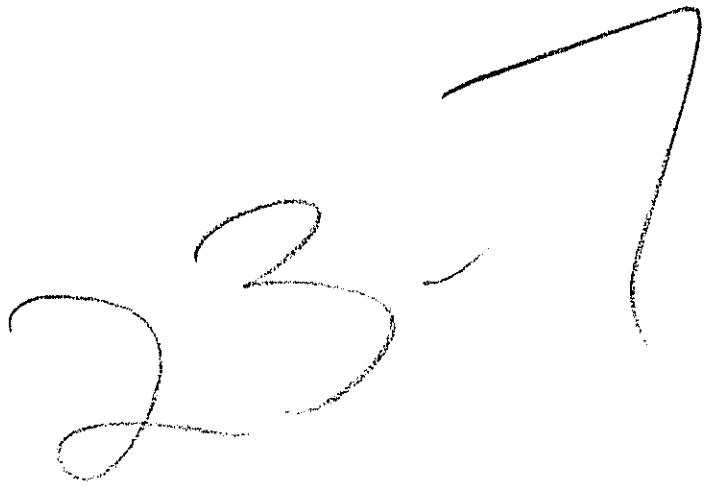
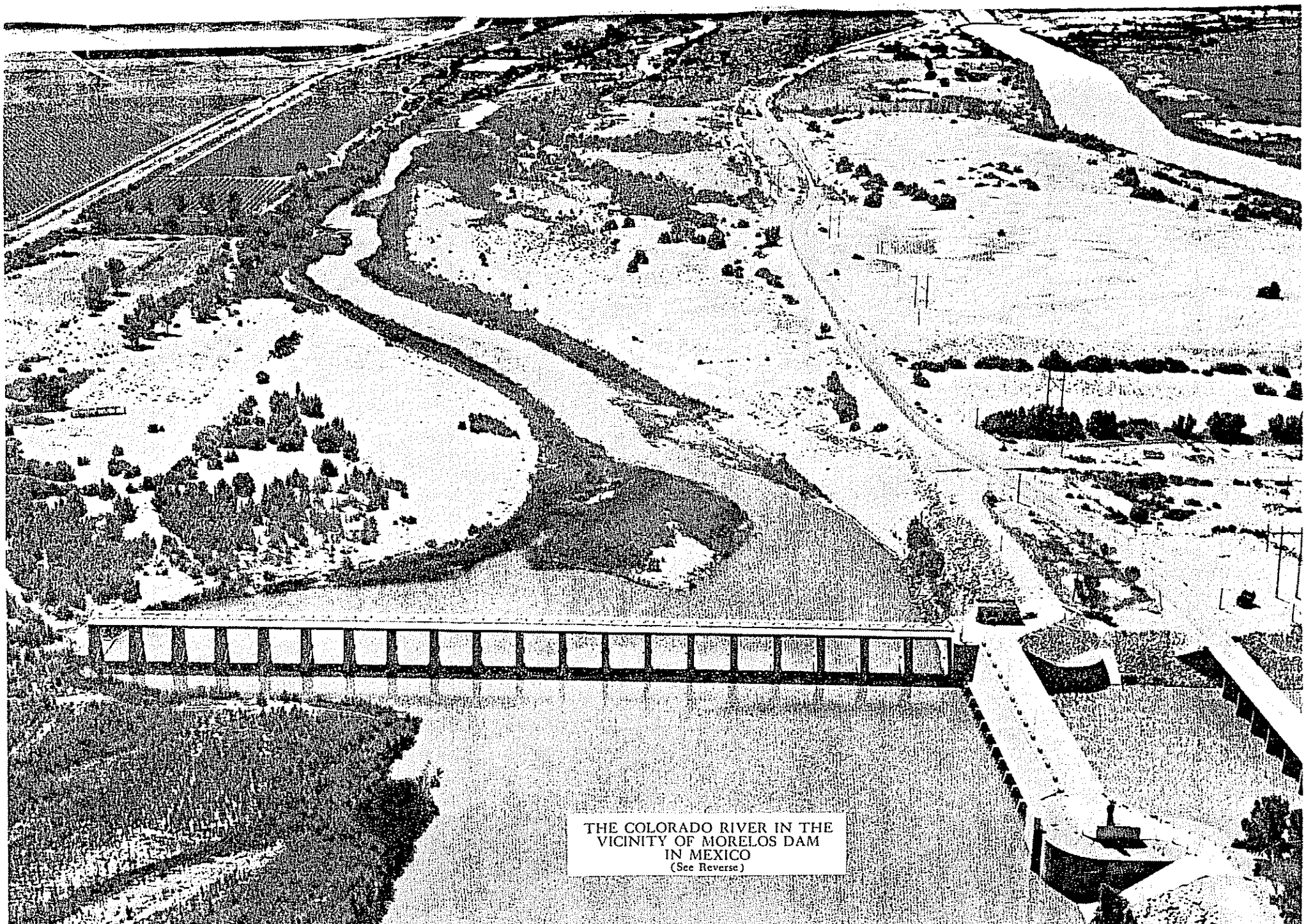


SALINITY PROBLEMS
in the
LOWER COLORADO RIVER AREA

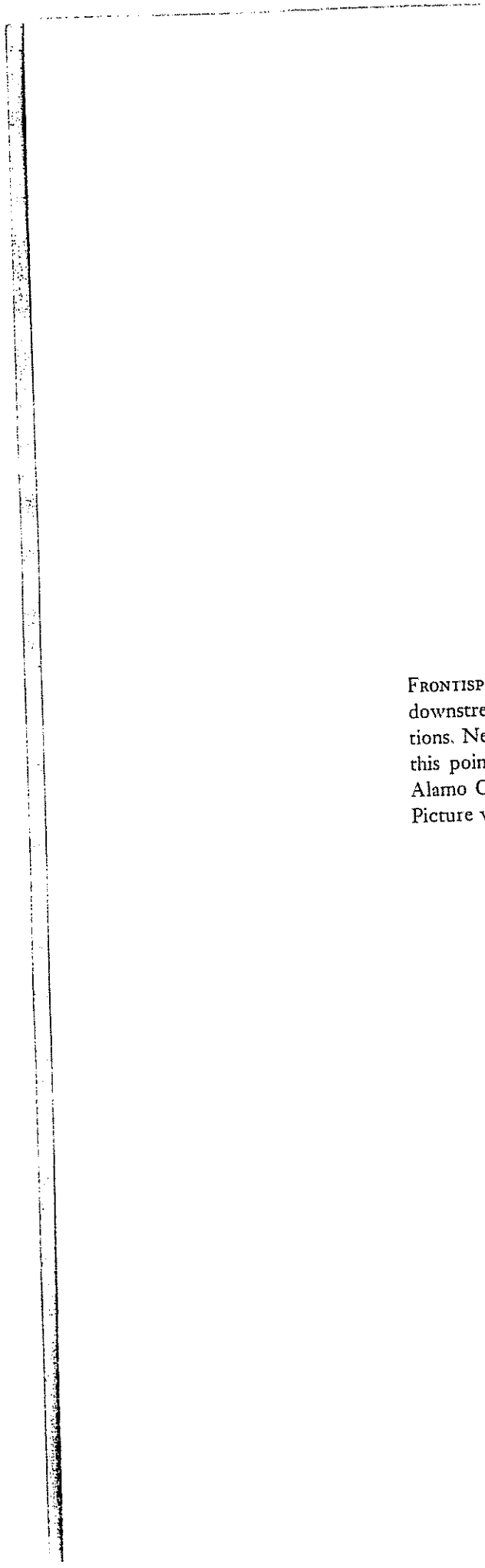
COLORADO RIVER BOARD
OF CALIFORNIA

A.A.C., Section
Floor

STATE OF CALIFORNIA
September 1962



THE COLORADO RIVER IN THE VICINITY OF MORELOS DAM IN MEXICO
(See Reverse)



FRONTISPIECE—Aerial view looking southward and downstream. The scene is typical of present conditions. Nearly all of the flow of the Colorado River at this point is diverted by the intake structure of the Alamo Canal (shown in the lower right foreground). Picture was taken on September 28, 1962.

COLORADO RIVER BOARD OF CALIFORNIA

SALINITY PROBLEMS

in the

LOWER COLORADO RIVER AREA

September 1962

This report prepared under direction of

W. DON MAUGHAN

by G. W. LEE
R. H. FIGUEROA

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INTRODUCTION

The purposes of this report are to outline briefly the overall problem of water quality in the Lower Colorado River area, to describe the physical situation along the lower main river as to diversions, wastes and return flows, to present summaries of data on flows and mineral contents, and to discuss in some detail the recent international situation between the United States and Mexico regarding the quality of the water delivered to the Mexican boundary under the terms of the Mexican Water Treaty of 1944. The report concentrates primarily on this international problem because it is acutely symptomatic of the potential problems that may arise in the future among different interests in the United States portion of the Colorado River Basin. Appendixes of detailed statistical information and extracts from official documents are available upon request.

It has long been recognized that the problem of water quality is inter-related with and equal in importance to the problem of water quantity in the planning and development of the water resources of a river basin. The problem of the chemical quality of the water is of particular significance in the Colorado River Basin because of the geographic and legal situation and because of the inability of the dependable water supply of the river to meet all existing and potential demands upon that supply. The main river is nearly 1,400 miles long and offers innumerable opportunities for the diversion and use of water and return of excess diversions and drainage which increase the mineral content of the flow of the stream.

Colorado River becomes progressively saltier as it makes it journey from the headwaters to the international boundary between the United States and Mexico. The accompanying chart, Plate 1, shows that the mineral content, expressed as the average for the latest five-year period of complete published data for all sampling points, 1953-57, increases progressively downstream from about 90 parts per million near the headwaters to more than 800 parts per million in the lower reaches of the river.

The lower river probably will become more saline in the future as upstream irrigation activities increase. Many authorized projects in the Upper Basin remain to be constructed, and many existing projects are not yet fully developed. Increased consumptive use of the waters of the Colorado River and its tributaries in the Upper Basin, particularly the relatively pure water of the headwater streams, will result in higher concentrations of mineral salts in the residual flow downstream. It has been estimated that under future conditions the total dissolved solids at Imperial Dam may be as much as 1,150 parts per million, or about a 50 percent increase over recent past conditions. The anticipated result will be a need for a greater quantity of water to irrigate the same unit of land in the lower river area. Because of the increase in mineral content, more water will be required for leaching purposes and to maintain favorable salt balance in the irrigated areas. This problem concerns water users throughout the basin, but especially those in the Lower Basin states. If the people of the basin states and the Congress are to act intelligently in planning further development of the river, they must have complete information on a number of very important questions relating to the quality of the water of the river system.

A case in point is the controversy with Mexico which arose in the late fall of 1961 when the mineral content of the water arriving at the international boundary rose markedly as compared with the mineral content during the preceding summer months and as compared with the mineral content in the winter months of previous years. Whether the increased salinity caused the crop damage claimed by Mexican interests cannot be determined from facts available. It is known that the concentration of dissolved solids in parts per million increased from about 1,100 in March 1961 to about 2,700 during parts of November and December 1961. This relatively sudden and marked increase in salinity of the river water was caused by a combination of factors —minimum releases from upstream storage under a tight operation schedule, reduction of delivery orders by Mexico to the minimum rate permitted by the Treaty and the operation of a recently completed major pump drainage system in the Wellton-Mohawk unit of the Gila Project, east of Yuma, Arizona. Drainage water from the Wellton-Mohawk unit carries 6,000 to 6,500 parts per million (ppm) or as much as nine tons of dissolved solids per acre-foot of water.

Plate No. 2 depicts recent variations in flow and quality of the Colorado River at Cibola Valley, 38 miles upstream from Imperial Dam, and at the northerly international boundary; and of the Wellton-Mohawk drainage. It will be noted that during late November and early December 1961, when the Wellton-Mohawk Drainage Channel was not in operation, the amount of total dissolved solids at the northerly boundary was appreciably reduced.

The operation of this drainage system triggered considerable agitation in the Mexicali Valley in Mexico. Farmers of Mexicali Valley complained to their government that the water they were receiving was unfit to use. Protests were lodged with the United States State Department and notes were exchanged between the two governments.

HISTORIC CHANGES IN RIVER REGIMEN

For about the first third of this century, 1900-1934, representing the initial era of intensive irrigation development in the Yuma area, the lower Colorado River fluctuated from a turbulent muddy torrent with some disastrously high peak flows during flood seasons to a mildly flowing stream of insufficient supply in dry seasons. Prior to completion of Hoover Dam and the All-American Canal, there were constant operation and irrigation difficulties owing to recurring floods and periods of drought. The extremes of these conditions were the 1905 flood when control of the river was lost and Salton Sea was created; and the drought of 1934 which ironically occurred just one year before storage was available at Hoover Dam. Recorded maximum and minimum flows at Yuma above the point where Imperial Valley was diverting were 250,000 cubic feet per second (cfs) and 18 cfs respectively. Over the years, as depletions upstream increased, the flow in the river gradually lessened and the salt content gradually increased.

From 1904 to 1942 the water supply to Imperial and Mexicali Valleys was conveyed by the old Alamo Canal and shared by the United States and Mexico. The quality of the water during this period was identical for the irrigated areas on both sides of the border.

With closure of Hoover Dam in 1935 the lower river underwent an abrupt change in regimen. For the next quarter century, 1936-61, it was a controlled river with no

damaging flood waters or excessively low flows. This change in regimen was of great benefit to Mexican as well as American water users. Near the end of the period, upstream developments had reached the stage at which much of the dependable water supply was committed and the flow at the boundary appreciably reduced. The increase in salt content in this period was more perceptible than formerly, particularly between 1955 and 1961 when a prolonged drought in the basin curtailed the flow.

Operation under the Mexican Water Treaty benefited Mexico not only by guaranteeing a specific minimum annual quantity of water at the border but also by delivering the waters, in the words of the then Boundary and Water Commissioner for Mexico, "regulated by the American works, and at the appropriate time for their application to the lands."

TREATY AND COMPACT INTERPRETATION

The problem of the chemical quality of the water in Colorado River at the Mexican boundary is particularly vexing because of the failure of the 1944 Treaty to cover explicitly the matter of water quality. Although the Treaty by its terms guaranteed to Mexico a minimum annual delivery of 1.5 million acre-feet of water from the Colorado River System it did not expressly state whether there was to be any guarantee as to quality. United States negotiators in Senate committee hearings testified that Mexico was to accept any water delivered according to Treaty schedule regardless of source or quality. Mexican negotiators on the other hand assured their government that Mexico was to receive water as good as the supply delivered to United States projects along the lower river. California and Nevada officially opposed the terms of the Treaty and warned that because of the water quality problem, among others, there would be trouble ahead.

Article 10, Section III of the Treaty reads:

> "Of the waters of the Colorado River, from *any and all* sources, there are allotted to Mexico. . . ." (Emphasis supplied.)

and Article 11 (a):

> "The United States shall deliver all waters allotted to Mexico wherever these waters may arrive in the bed of the limitrophe section of the Colorado River . . . Such waters shall be made up of the waters of the said river, *whatever their origin.* . . ." (Emphasis added.)

The Colorado River Board of California on February 23, 1945, recommended to the Senate Committee on Foreign Relations, which was conducting the Treaty ratification hearings:

> "That there be an express declaration that the quality of the waters to be delivered to Mexico is not guaranteed but that Mexico agrees to accept, *regardless of quality*, as part of the waters allotted to her under the treaty, any waters reaching the international boundary.
>
> . . . Whether the treaty requires Mexico to accept Colorado River water, regardless of quality, was a question on which witnesses most positively and emphatically differed. Hence, the treaty provisions are not stated with certainty. Controversy is sure to arise when development in the United States relegates most of Mexico's quota to the class of highly saline return flow. To deal fairly with Mexico, and avoid bitter controversies, the interpretation insisted upon by American negotiators must be made clear beyond all question by adding the words '*regardless of quality*'." (Emphasis added.) *Hearings Before the Committee on the Treaty with Mexico Relating to the Utilization of the Waters of Certain Rivers*, 79th Cong., 1st Sess., pt. 5, at 1791-92 (1945).

Throughout the 1,800 pages of the hearings on the ratification of the Mexican Water Treaty, California's Senator Sheridan Downey made repeated but unsuccessful attempts to insert those crucial words, "regardless of quality."

Despite California's protests the American negotiators, in their testimonies before the Senate Committee on Foreign Relations, were adamant in their assertions that the language of the Treaty was plain and that the Mexicans clearly understood that quality was not guaranteed. These views apparently were not shared by the Mexican negotiators. Six months after the United States Senate hearings a Mexican engineer who was a

participant in the negotiation of the Treaty was quoted in the Mexican press that the water to be delivered must be of good quality and fit for irrigation purposes. It is abundantly clear today that the Mexicans feel there is an obligation under the Treaty for the United States to deliver usable water.

Thus, the present controversy arises against a background of a lack of mutual assent on the quality of water to be delivered under the provisions of the Mexican Water Treaty, and for that reason the current problem has many facets:

1. Has the United States any legal obligation to resolve the problem?
2. If not, has the United States nevertheless a moral obligation as a matter of international comity?
3. If the United States does have a legal obligation, what physical solution to the problem can be devised with the minimum detrimental effects upon United States projects?
4. If there is no legal obligation, can a physical solution be attained without implying such legal obligation and without setting a precedent damaging to the rights of the Colorado River Basin states under the Treaty?
5. If, as some have suggested, facilities were constructed to permit bypassing the more saline drainage waters below Morelos Dam, the Mexican diversion structure, should the water so bypassed still be considered as part of the scheduled delivery to Mexico under the Treaty?

Corollary questions include:

6. What effect would the bypassing of the Wellton-Mohawk drainage have in regard to the provision in the 1947 Gila Project Reauthorization Act that the Wellton-Mohawk Division be limited to 300,000 acre-feet a year of beneficial consumptive use of water diverted from the Colorado River?
7. What obligation does the Gila Project or the Wellton-Mohawk unit thereof have to alleviate the situation? Is the drainage operation of the Wellton-Mohawk unit to be considered fair and reasonable in domestic or international law?

The Colorado River Basin states and the United States government appear to be unanimous in the position that the United States has no legal obligation under the Treaty and that nothing should be done which would involve any modification of the terms and conditions of the Treaty. They appear to agree however, that the United States in recognition of its good neighbor policy should do something as a palliative to the situation, within the limits of the Treaty. It is essential to observe Treaty provisions for the amount of water to be delivered to Mexico because the Colorado River flow already is fully committed for existing, authorized and proposed projects and it is not possible to give additional water supplies to Mexico without depriving American citizens of water urgently needed for domestic, industrial and agricultural purposes.

The Colorado River Compact provides in Article VIII that "present perfected rights to the beneficial use of water are unimpaired by this Compact." California has long contended that "unimpaired" applies to quality as well as to quantity. Repeatedly California spokesmen have expressed concern as to the effect of existing and proposed developments in the Upper Basin on the quality of water available to the Lower Basin, and have urged that investigations be completed to determine those effects.

LOWER BASIN PROJECTS

Major United States projects divert and use water from the main Colorado River in the reach between Lake Mead and the international boundary. In geographic groups these are (a) those diverting above Imperial Dam: The Metropolitan Water District of Southern California; the Colorado River Indian Reservation in Arizona; the Palo Verde Irrigation District, California; and (b) those diverting at Imperial Dam: the Imperial Irrigation District and the Coachella Valley County Water District in California; the Reservation Division of the Yuma Project in California; the Valley Division of the Yuma Project in Arizona; the Gila Project in Arizona; and the City of Yuma, Arizona. (See Plates 3, 4 and 5.) Several small areas in Arizona outside the Gila and Yuma Projects are served by the Gila Project Canal, including the Yuma Auxiliary Project of about 3,300 acres. In addition, a number of small, unauthorized and unmeasured diversions are scattered along the river.

Gross diversions in calendar year 1961, including rediversion of return flows, totaled about 7.3 million acre-feet as compared to a release from Lake Mead in the same year of about 8.6 million acre-feet. Gross and net diversions of the major entities during calendar year 1961 are shown in the following table.

	Unit—1,000 acre-feet		
Project	*Gross diversion*	*Measured return*	*Net diversion*
Metropolitan Water District, California	1,102	11	1,091
Colorado River Indian Reservation, Arizona	437	267	170
Palo Verde Irrigation District, California	935	555	380
Imperial Irrigation District, California	3,036	0	3,036
Coachella Valley County Water District, California	522	0	522
Yuma Project, Reservation Division, California	91	51	40
Yuma Project, Valley Division, Arizona	353	171	182
Gila Gravity Main Canal, Arizona	818	192	626
Total	7,294	1,247	6,047

For the past two years nearly all the flow in the river at Imperial Dam has been diverted at the dam. Only seepage and sluicing waters to clear the channel of sediment have been flowing down the riverbed. Some of the water diverted on the California side into the All-American Canal returns to the river at the Siphon Drop Power Plant and the Pilot Knob Power Plant. The discharges from the power plants flow on into Mexico to the Morelos diversion dam and are of the same quality as the water being delivered to American projects. Water diverted on the Arizona side of the river flows in the Gila Gravity Main Canal to several units in the Gila Project, Arizona, and the relatively small miscellaneous acreages outside the Gila and Yuma Projects.

CALIFORNIA PROJECTS
(Gross area in parentheses)

Metropolitan Water District (4,000 square miles)

The District diverts water from Havasu Lake above Parker Dam, which is 175 miles above the northerly international boundary, through the 240-mile Colorado River

Aqueduct to serve supplemental water for municipal and industrial use to eight million people on the coastal plain of Southern California. Annual capacity of the aqueduct is 1,212,000 acre-feet. Return flow to the river is negligible.

Palo Verde Irrigation District (120,500 acres)

About 75,000 acres of the Palo Verde District are developed and under irrigation. The Palo Verde diversion dam is 118 miles above the northerly boundary. Drainage re-enters the river in a main drain at the lower end of the project, about 50 miles above Imperial Dam, and by unmeasured underground seepage.

Imperial Irrigation District (1,000,000 acres)

There are 745,000 net irrigable acres of land within the service area of the District in addition to cities, towns, etc. The net acreage irrigated increased from zero in 1900 to 141,030 in 1908 and 436,000 in 1961. By 1961 over 280,000 acres of farmland had been provided with underground tile drainage and about 1,400 miles of outlet drain ditches had been constructed. All the drainage return from Imperial Valley flows into Salton Sea, along with a recently increasing amount of drainage and domestic sewage from Mexicali Valley.

Coachella Valley County Water District (137,900 acres)

Water distribution facilities have been completed for 74,500 acres in Coachella Valley. About 50,000 acres are presently irrigated. An extensive tile and ditch drainage system has been constructed and all the return flows enter Salton Sea.

Yuma Project, Reservation Division (25,000 acres)

The California part of the Yuma Project is north of and across the Colorado River from Yuma, Arizona. About 16,000 acres are within the service area of the water distribution system. The irrigated area has been consistently about 10,000 acres since 1921. Water was first delivered in 1910, from Laguna Dam, and now is diverted at Imperial Dam via the All-American Canal.

Drainage from the Division is discharged into the Colorado River by the Reservation Main Drain and the Araz Drain, which also collect seepage water from the All-American Canal.

ARIZONA PROJECTS

Colorado River Indian Reservation (100,000 acres)

About a third of the gross area is under irrigation. Diversion is at Headgate Rock Dam, 160 miles above the boundary. Drainage returns to the river at the lower end of the area, 118 miles above Imperial Dam, and by unmeasured underground seepage.

Yuma Project, Valley Division (50,000 acres)

The area irrigated has been consistently more than 40,000 acres since 1918. Water is diverted at the California side of Imperial Dam and conveyed by the All-American Canal to the Yuma Main Canal which passes under the Colorado River in a siphon to the Arizona side, where it divides into the East and West Main Canals. Three spillways from the West Main Canal discharge into the limitrophe section of Colorado River, the reach between the upper and lower Mexican boundaries. Waste from the East

Main Canal crosses the land boundary into Sonora. Soil drainage is accomplished by wells and a main drain, and the effluent is pumped across the southerly international boundary into Mexico at San Luis. Since mid-1956, the flows crossing the land boundary have been accepted by Mexico in partial satisfaction of the Treaty delivery obligation of the United States.

Gila Project

First authorized in 1937 and reauthorized in 1947 with a change in area, the Gila Project now consists of four units—the Wellton-Mohawk Irrigation and Drainage District, the North Gila Valley Irrigation District, the Yuma Irrigation District (South Gila Valley) and the Yuma Mesa Irrigation and Drainage District. All are now or soon will be served by the Gila Gravity Main Canal heading at Imperial Dam. The canal extends southward from the dam, passes under the Gila River in a siphon, and then branches into two directions, one eastward to the Wellton-Mohawk area, the other southward to Yuma Mesa. The south branch also serves the Yuma Auxiliary Project and miscellaneous areas. (See map, plate 5.)

North Gila Valley Irrigation District (7,000 acres). Diversions from the mainstream at Laguna Dam began soon after the construction of the dam in 1909. The North Gila Valley Irrigation District was organized in 1919. Since 1955 about 6,300 acres have been irrigated annually and all deliveries have been made from Imperial Dam through a turnout on the Gila Gravity Main Canal.

Surplus diversions are returned in three wasteways, two discharging into the Colorado River and one into the Gila River. Several relatively small surface drains discharge into the Colorado River.

Yuma Mesa Irrigation and Drainage District (20,000 acres). This unit is on a mesa adjacent to and overlooking Yuma and South Gila Valleys. Presently about 16,000 acres are irrigated. There are no measurable quantities of surface return flow from this unit or the adjacent Yuma Auxiliary Project. However, excess water applied and seeping past the plant root zone is asserted to be the cause of rising ground water tables and aggravation of drainage problems in Yuma and South Gila Valleys. There is evidence that some water escapes underground to Mexico.

Yuma Irrigation District—South Gila Valley Unit (10,000 acres). Until now this fully developed unit of the Gila Project has been dependent on ground water as a source of supply, but a recent contract with the Bureau of Reclamation for the delivery of 130 cfs of water from the Gila Gravity Main Canal will permit surface water irrigation of 8,770 acres of land. The remaining portion will continue to be supplied with ground water.

In recent years, the Valley has been plagued with high ground water table. An open drain was constructed along the toe of the mesa discharging into the Colorado River and nine drainage wells, with pumps of 10 cfs capacity each, discharge by outlet channels into the Gila River. The pump drainage outlet channel last built started operation on January 12, 1962.

Wellton-Mohawk Irrigation and Drainage District (75,000 acres). This unit of the Gila Project, the largest single irrigation development in the Yuma area, lies along both sides of the Gila River east of Yuma in a relatively narrow strip about 50 miles long with a maximum width of about 6 miles.

Irrigation in the Wellton-Mohawk area began before the turn of the 20th century with surface diversions from the Gila River. In the 1920's wells were drilled to supply 9,000 acres with water from underflow of the river. Construction of upstream storage dams and extensive development of the Phoenix area, including massive exploitation of the ground water basins, practically eliminated the Gila River underflow in the Wellton-Mohawk area. By 1946, water from some of the wells carried nearly half as much mineral content as sea water. The overall poor quality of the water brought about abandonment of many farms and reduced the active lands to about 6,000 acres of salt-tolerant crops.

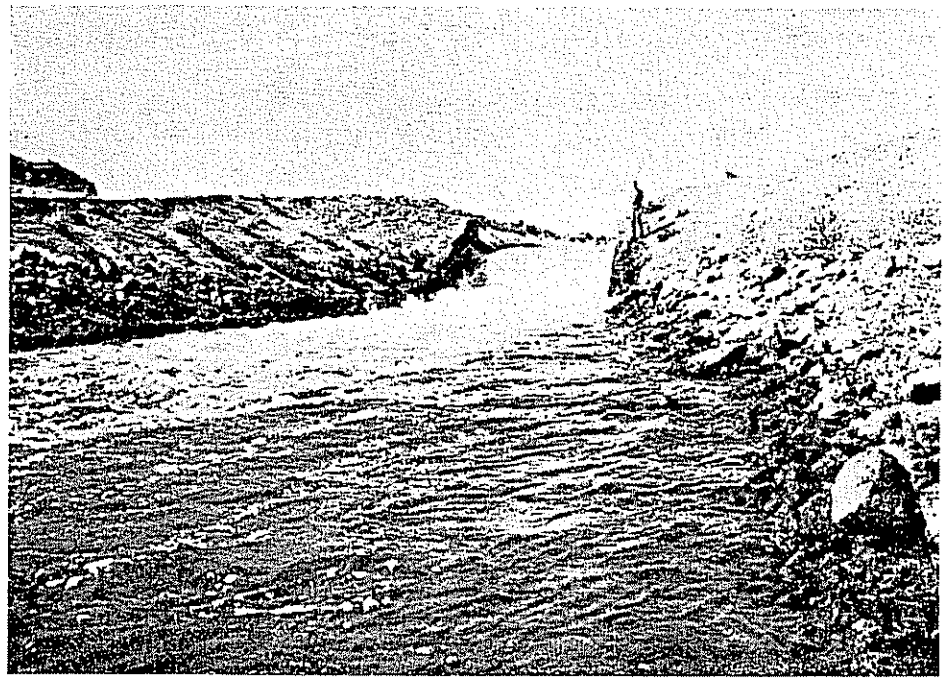
In 1952 the Bureau of Reclamation completed the Gila Project works to bring an ample supply of better water from the Colorado River into the area. More than 50,000 acres are now irrigated in the Wellton-Mohawk unit. However, adequate drainage facilities were not provided in the original construction of the project and the water which brought its blessings also brought a curse in the form of a rising ground water table. In 1959 the first of 70 drainage wells were installed in an attempt to alleviate the waterlogging of farmlands. For several months the wells discharged into the nearest points in the bed of the Gila River, but in 1961, a conveyance channel more than 50 miles long and of about 300 cfs capacity was completed to carry the effluent into the Gila River near its confluence with the Colorado River. The photographs on the next page showing flows of about 285 cfs were taken on June 13, 1962.

The wells are said to be working effectively, not only to arrest the spread of the damage caused by high water table, but to make possible the reclamation of lands which had gone out of production. Ironically, this curative measure has proved to be a source of distress to others—the City of Yuma and the Mexican users of Colorado River water.

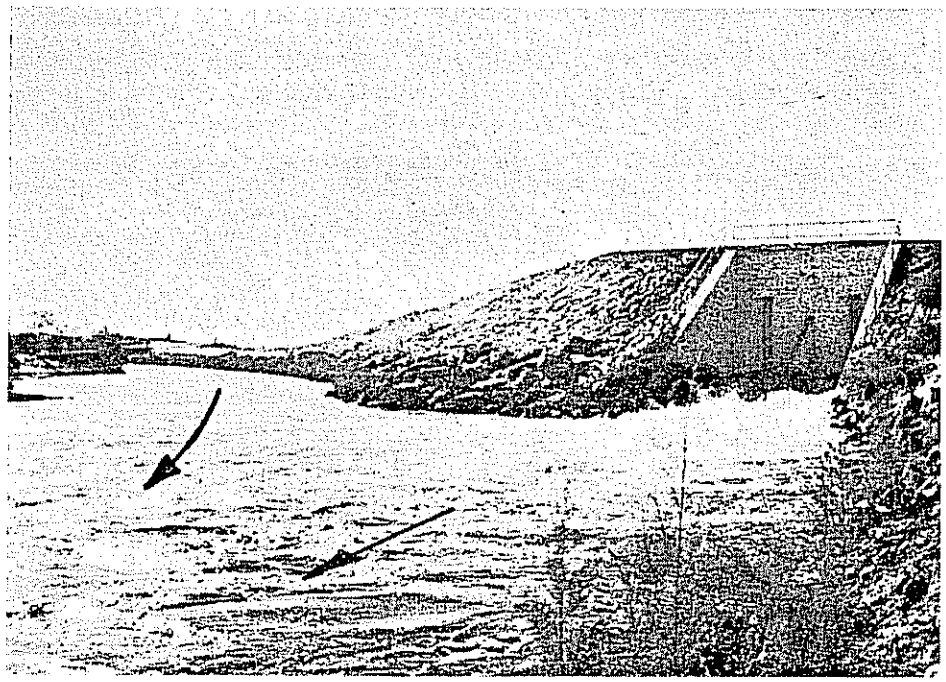
City of Yuma

The city, which formerly received its water supply from the Colorado below the mouth of the Gila River, was the first major user to be adversely affected by the return flows from Wellton-Mohawk. Degradation of quality was noticeable as early as September 1960. By permission of the Yuma County Water Users Association the Arizona Water Company, which furnishes water to the City of Yuma, began diverting a third of the city's requirements from the Yuma Main Canal which carries water identical in quality to that in the Colorado at Imperial Dam. Since February 1962, the company, under a two-year contract with the Association has pumped its entire supply from the canal. A 1959 contract between the city and the Secretary of Interior provides for delivery of the water immediately below Imperial Dam. This point of delivery is about 18 miles upstream from the mouth of the Gila.

WELLTON-MOHAWK MAIN DRAINAGE CONVEYANCE CHANNEL



Dissipation Works At Terminus of Lined Portion of Channel.



Discharge of the Channel Into the Gila River.

MEXICALI VALLEY

The history of irrigation in Mexicali Valley is contemporaneous with that of the Imperial Valley. The right to divert up to one-half the water flowing in the Alamo Canal was reserved to irrigate Mexican lands in return for the concession by the Mexican Government to predecessors of the Imperial Irrigation District of the right to convey Colorado River water in the canal through Mexican territory. In 1920, 220,000 acres were irrigated in Mexico and in 1942, at the completion of the All-American Canal, 260,000 acres. Ratification of the 1944 Treaty, with its guarantee of minimum annual quantities of water at regulated rates resulted in a large increase in irrigated acreage; it reached a maximum of more than 500,000 acres in 1957, and is reported to be 410,000 acres in 1962.

Water for irrigation of the land west of the Colorado River is diverted from the river at Morelos Dam a mile below the California-Mexican boundary and conveyed through the Alamo Canal and branches thereof. In addition, about 500,000 acre-feet a year of ground water is pumped into the canals from wells in the eastern portion of the area. Mineral content of the ground water is said to average about 1,400 ppm.

Waste and drainage water from the Yuma Valley Project is taken across the land boundary at San Luis into a canal system which serves lands in Sonora, east of the Colorado River. In addition a number of diversions are made by pumping directly from the river. It is reported that all but one of these pumped diversions will be replaced upon completion of a siphon now under construction to convey water from the Alamo Canal under the river to the east side.

Substantial quantities of waste water from the Alamo Canal and drainage and domestic sewage from Mexicali Valley re-enter the United States in the channels of the New and Alamo Rivers. Little adequate drainage has been provided in the Valley however.

The soils are generally tight and because of the lack of adequate drainage the salts in the irrigation water have accumulated in the soils to the extent that serious problems of soil salinity exist in many parts of the Valley. Thus the problem in the Mexicali Valley has been building up over the past half century by failure to achieve a favorable salt balance in the soils. The beginning of the highly salinized outflow from the Wellton-Mohawk area has simply aggravated the problem into an acute status.

Crops grown in Mexicali Valley are largely cotton and winter wheat. In 1961 over 70 percent of the crop land was planted to cotton. For this reason, and because the water requirement of winter wheat is comparatively small, the demand for water for irrigation is high in the summer and relatively low in the winter.

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NEED FOR PROPER IRRIGATION AND DRAINAGE PRACTICES

Success in the raising of irrigated crops rests to no inconsiderable degree upon leaching of the soil, tolerance of the planted crop to salt, drainage of the soil and proper management practices. Of these, drainage is a highly significant factor. Cultivated crops use only negligible amounts of nutrient salts. Generally speaking commercial crops are not tolerant of heavy concentrations of dissolved minerals either in the soils or in the irrigation water. For these reasons it is essential to successful irrigated agriculture that in the beginning any excess amount of salts in the natural soil be leached out and that thereafter a favorable salt balance be maintained by carrying away from the area at least the same amount of dissolved mineral content that is brought in by the applied irrigation water. This is accomplished by applying enough water to carry the unused salts into the soil below the plant root zone and into a drainage system which will collect and convey it to a disposal area or stream.

Since different species of cultivated plants differ widely in salt tolerance, and since soil characteristics and other pertinent factors differ widely, standards for the chemical quality of irrigation waters cannot be absolute. Standards established therefore generally cover a reasonable latitude depending not only upon the factors mentioned above, but upon the relative proportions of the various constituents of the chemical content of the irrigation water. Water used in some places and under some circumstances is considered unusable in others. For example, although the Mexican farmers complained in December 1961 that waters containing 2,700 ppm of dissolved solids were useless to them, farmers in several locations in southwestern United States customarily and satisfactorily irrigate crops with water containing more than 4,000 ppm of dissolved solids. Water with mineral contents as high as 6,000 ppm has been used for years in irrigation of lands near Gillespie Dam, on the Gila River between the Phoenix area and the Wellton-Mohawk area.

The following approximate limits of use of irrigation waters are derived from broad classifications given in United States Department of Agriculture Handbook No. 60, "Diagnosis and Improvement of Saline and Alkaline Soils," issued in February 1954:

> Low salinity water (60 to 150 ppm) can be used for irrigation of most crops on most soils with little likelihood that soil salinity will develop.
>
> Medium salinity water (150 to 450 ppm) can be used with a moderate amount of leaching. Plants with moderate salt tolerance can be grown in most places without special practices for salinity control.
>
> High salinity water (450 to 1,350 ppm) cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.
>
> Very high salinity water (1,350 to 3,000 ppm) is not suitable for irrigation under ordinary conditions, but may be used occasionally under special circumstances. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching, and very salt-tolerant crops should be selected.

According to the handbook, study of more than 1,300 sources of irrigation water indicates that less than 10 percent of the samples were in the very high salinity range (1,350 to 3,000 ppm).

The Imperial Irrigation District, California, provides a prime example of the profitable irrigation of fine-textured soils of poor natural drainage with water which on the basis of data in Handbook 60 is "high salinity water." Records by the Imperial Irrigation District, from 1944 through 1955, show a salt content of water in the All-American Canal varying from about 680 to 860 ppm (0.93 to 1.17 tons per acre-foot of water).

Geographically and geologically, the Imperial and Mexicali Valleys are one. Imperial Valley farmers initially faced the same problems which now confront the Mexicans, but the Imperial Valley farmers leached their soils and installed extensive drainage facilities to avoid excessive salt accumulations.

The soil in Imperial Valley is complex, with no particular pattern or soil profile. By 1922 substantial areas in the valley had gone out of production because of drainage and salinity problems. Starting then, drain ditches and subsequently tile drains were constructed and the systems have been extended every year. In the period of record, since 1943, the salt content of the water discharged from the District into the Salton Sea varied from 2.03 to 3.42 tons per acre-foot. The gain in removal of salt from 1949 to 1955 inclusive was about 1¾ million tons.

In contrast, it is said that the struggle against soil salinity and alkalinity in the Mexicali Valley has always been and still is losing ground.

Authorities state that even without the incidence of the Wellton-Mohawk drainage channel effluent, users in the Mexicali Valley would still face a salinity problem because of the lack of adequate drainage facilities. The Mexicans themselves have recognized that a part of the problem is attributable to the need for drainage and better irrigation practices. Nevertheless the Mexicali Valley farmers have overextended their irrigated area by planting more acreage than can be irrigated and drained properly with the available water supply.

It is reported that although the Mexicali Valley now has about 900 miles of open drain ditches, it has need for at least 900 miles more ditches and for extensive tile draining of farmlands. No tile drains exist now. Also the water distribution system is said to be badly in need of rehabilitation and improvement to reduce the loss of water to seepage and non-beneficial plant growth.

SOURCES OF WATER AND MINERALS AT NORTHERLY INTERNATIONAL BOUNDARY

RIVER OPERATION

The 1944 Water Treaty which guarantees Mexico delivery of a minimum of 1,500,000 acre-feet of water a year, also specifies minimum rates at which the water can be ordered by Mexico. These are 1,500 cfs in the summer and 900 cfs in the winter. Orders, submitted in weekly schedules, can vary between these minima and 5,500 cfs maximum. Any water arriving at the border in excess of the scheduled amounts is not chargeable under the Treaty. It was stated at the United States Senate committee hearings on the Treaty that the reason for the 900 cfs winter minimum is to provide that substantially all the drainage water from the United States projects arriving in the limitrophe section will be chargeable to Mexico under the Treaty. Recent experience has indicated that the average winter returns, leakage and minimum sluicing waters exceed 900 cfs by about 400 cfs. Only about 650 to 700 cfs of the 900 cfs minimum are required at the northerly boundary to be available for diversion at Morelos Dam into the Mexicali Valley because about 200 to 250 cfs of return flows appear in the limitrophe section below Morelos Dam or are pumped across the boundary near San Luis from the main drain of the Valley Division of the Yuma Project in Arizona. Scheduled deliveries to Mexico are regularly reduced in the fall of the year to about 900 cfs as the demand for irrigation water decreases, and customarily remain at or near the minimum for the five months, October through February, the winter season defined in the Treaty.

The Bureau of Reclamation has the operational task of insuring that Mexico receives its water at the specified time and place. In performing this task, the Bureau inventories the sources of water that are available other than releases from storage dams. Among these sources are wasteway flows, leakages from Imperial Dam, tributary flows such as the Gila River, and return flows from irrigation projects.

Difficulties of river operation are numerous, owing to the time required for water releases to travel the great distances from the upstream storage reservoirs to Imperial and Morelos Dams, rapid changes in the weather and the consequent effects on water orders, unauthorized diversions and other factors. As a result, since operation under the Treaty provisions began, Mexico has always received more water than was ordered, even in years of low runoff and tight operation. For example, the average annual excess delivery for 1956, 1960 and 1961, years of stringently regulated supply in the Colorado River Basin, was 475,000 acre-feet.

When the scheduled deliveries to Mexico were reduced in the fall of 1961, the effec of the Wellton-Mohawk drain water on the quality of the river flow at the northerly boundary became more pronounced than before, and serious complaints were mad by the water users in Mexico. During part of December the Mexican farmers refuse to use the water. In January 1962, Mexico increased its order above the minimum i order to improve the water quality at Morelos Dam for irrigation of winter whe with the understanding that summer deliveries would be reduced accordingly. I March, as is customary, the orders were increased because of the advent of the cotto

growing season. Monthly orders, actual arrivals and mineral content at the boundary for October 1961 through July 1962 are as shown in the following table. The figures indicate how the salt concentration varied somewhat inversely as the variation in monthly flow.

	Total waters entering Mexico *		*Colorado River at northerly boundary*		
				Average total dissolved solids	
Month	*Orders, avg. cfs*	*Flow, avg. cfs*	*Flow, avg. cfs*	*ppm*	*tons/a.f.*
October 1961	900	1,209	964	2,480	3.37
November	900	1,188	962	2,360	3.21
December	900	1,540	1,329	2,070	2.82
January 1962	1,977	2,815	2,615	1,740	2.37
February	1,138	1,441	1,216	2,460	3.35
March	3,296	3,567	3,335	1,300	1.79
April	3,487	3,624	3,387	1,310	1.79
May	1,865	2,282	2,038	1,790	2.43
June	2,731	2,809	2,586	1,470	2.01
July	3,316	3,433	3,216	1,270	1.73

* Includes deliveries at land boundary.

SALT LOADS

The Colorado River Aqueduct Project, one of the three projects diverting from the main river between Hoover and Imperial Dams, has no effect upon the quality of the water in the river. There is only a small wasteway return from the diversion to the Aqueduct. The other two projects, the Palo Verde Irrigation District and the Colorado River Indian Reservation, return substantial quantities of drainage to the river with an average salt content of approximately twice that of the river. Whatever effect these returns may have would be reflected equally on both American and Mexican projects.

The average salinity content of the river below Hoover Dam for the 10-year period, 1951-60, was about 700 ppm (0.95 tons per acre-foot), whereas downstream at Imperial Dam the content was 770 ppm (1.04 tons per acre-foot).

The drains in Imperial and Coachella Valleys discharge their return flows into Salton Sea. Extensive and costly drainage systems cover nearly all the agricultural lands in those two valleys and were constructed in time to prevent or overcome deleterious accumulation of salts in the soil. Salton Sea contains nearly 35,000 ppm of dissolved solids or about the same as ocean water.

Leakages from Imperial Dam, and canal wastes below, carry about the same mineral content as the water in the river at Imperial Dam, but the drainage returns from the irrigation projects including the flow in the Gila River at its mouth are much more saline than the river water. The Gila has not carried any natural flow at its mouth other than local storm runoff since about 1941. Because of the heavy salt load added to the river by the irrigation returns, the mineral content at the international boundary and at Morelos Dam is considerably higher than the mineral content of the river at Imperial Dam, particularly in winter months when irrigation returns make up a major percentage of the total flow at the boundary. The average for the samples representative of the quality at Imperial Dam in the winter of 1961-62 was 844 ppm (1.15 tons per acre-foot) as compared to an average of 2,110 ppm (2.87 tons per acre-foot) for samples at the northerly boundary.

Sources and relative proportions of the total flow and salt load at the northerly boundary in the period October 1961 through February 1962 are shown diagrammatically on Plates 6 and 7 and quantitatively on the following table.

SOURCES OF WATER AND MINERALS

Colorado River at Northerly International Boundary *

October 1961 Through February 1962

Source	Water		Minerals	
	A.f.	Percent of total at boundary	Tons	Percent of total at boundary
MEASURED DRAINAGE RETURNS				
Wellton-Mohawk	80,510	18.9	661,030	54.1
Gila River	1,479	0.3	12,510	1.0
North Gila Valley	2,063	0.5	4,010	0.3
South Gila Valley	14,101	3.3	49,450	4.0
Subtotal Arizona	98,153	23.0	727,000	59.4
Yuma Reservation Division	18,558	4.3	26,160	2.2
Subtotal California	18,558	4.3	26,160	2.2
Total Arizona and California	116,711	27.3	753,160	61.6
MEASURED WASTEWAY RETURNS				
Imperial Dam release and seepage	104,462	24.5	117,000	9.6
Gila project	15,682	3.7	17,560	1.5
California wasteway (siphon drop)	35,980	8.4	40,300	3.3
Pilot Knob	126,560	29.7	141,750	11.6
Total Arizona and California	282,684	66.3	316,610	26.0
UNMEASURED NET RETURNS				
Imperial Dam to northerly boundary †	27,185	6.4	151,530	12.4
MEASURED NORTHERLY BOUNDARY	426,580	100	1,221,300	100

* Water available at Morelos Dam.
† Northerly boundary less sum of all measured return.

The Reservation Division of the Yuma Project is the only project on the California side below Imperial Dam which contributes drainage return to the river at the boundary. The total quantity of return in calendar year 1961 was about 51,600 acre-feet, or an average of about 70 cfs. Quality samples indicated about 1,000 ppm, or about 1.4 tons of total dissolved solids per acre-foot. Annual discharge from the Reservation Division including seepage from the All-American Canal picked up by the two drains constitutes only about 4 percent of the total annual return flow to the Colorado River between Imperial Dam and the northerly boundary. For the five months, October 1961 through February 1962, the discharge from the Reservation Division drains was 4.3 percent of of the total delivery at the boundary and carried 2.2 percent of the total salt load.

Drainage water from the Valley Division of the Yuma Project has in general about twice as much mineral content as the Colorado River at Imperial Dam. This water has been used for irrigation for many years without complaint by farmers on the Sonora

side of the Colorado River in Mexico. Records of Yuma Main Drain water quality have been kept by the Yuma County Water Users Association for about seven years, and the concentration of salt has been relatively steady at about 1,700 ppm, or 2.3 tons of total dissolved solids per acre-foot. The pumpage from the Yuma Main Drain at the boundary averaged about 185 cfs or a total of 133,600 acre-feet for calendar year 1961.

Drainage return from the Gila Project constituted about 23 percent of the total flow at the boundary in the five winter months, 1961-62, but carried 59 percent of the total salt load.

Return flow from the North Gila Valley Irrigation District during the five-month period, October 1961-February 1962, was one-half of 1 percent of the total flow at the boundary and contributed only one-third of 1 percent of the total salt load. Diversions for calendar year 1961 totaled about 90,000 acre-feet. The surface drainage returns averaged about 10 cfs, or a total of about 7,200 acre-feet. A few field samples indicate about 1,500 ppm, or two tons of dissolved solids per acre-foot.

Drainage from the South Gila Valley Unit generally represents a significant percentage of the total drainage discharged into the main stream by projects below Imperial Dam, and the salt concentration is greater than in the return flow from other projects in the area except the Wellton-Mohawk Unit. Operation of the South Gila Drainage Pump Outlet Channels No. 1 and No. 2 began in August 1961 and January 1962 respectively. The average return for the January-March period of 1962 has been about 75 cfs with salt concentration about 2,600 ppm, or 3.5 tons of total dissolved solids per acre-foot. During the five-month period shown on the charts the South Gila contributed 3.3 percent of the flow at the boundary and 4.0 percent of the salt load.

No doubt there was a large accumulation of salts in the ground water of the Wellton-Mohawk area prior to the importation of Colorado River water. The underground formation is described as a "shoestring" aquifer, about 50 miles long, 1 to 3 miles wide and 100 feet deep. In the Senate hearings on the Mexican Water Treaty, January 1945, part 2, p. 349, J. R. Riter of the United States Bureau of Reclamation testified as follows:

> Mr. Riter: "In the Mohawk area there was at one time 20,000 acres irrigated. These lands were irrigated by diverting the flood waters from the Gila River, which are erratic in occurrence, and only partly irrigated by recovery of ground waters. In 1943, the area irrigated in Mohawk Valley was only 8,000 acres.
>
> Senator McFarland: Right there, Mr. Riter: You mean by recovery of ground water, pumping?
>
> Mr. Riter: Yes, sir.
>
> Senator McFarland: That is water that is 12,000 parts per million?
>
> Mr. Riter: Yes, sir."

Water containing 12,000 ppm, about 16 tons of salt per acre-foot, is roughly four times as salty as the heaviest concentration arriving last winter at Morelos Dam.

By 1958, much of the Wellton-Mohawk land had become waterlogged, and in 1961 the salt content of the ground water was as much as 17,000 ppm in places. Steps were then taken to provide badly needed drainage. The drainage system, which began large scale operation in February 1961, consists of about 70 wells tapping the gravel layer at the bottom of the water-bearing formation and pumping into a lined drainage channel of 300 cfs capacity which carries the drainage to the mouth of the Gila River and thence into the Colorado River and on to Mexico. If, as reported,

the wells tap only the bottom layer of the aquifer, all excess water applied in irriga-tion will have to percolate through almost the entire 100-foot depth in order to be picked up by the pumps and carried out of the valley. Thus in the eyes of some drainage experts, before the salinity of the Wellton-Mohawk drainage water could be decreased to normal levels by this operation, the entire aquifer would have to be flushed and the entire volume of water freshened. This would require many years depending upon the volume and total salt load of the ground water in storage.

Diversion to the Wellton-Mohawk Unit from the Colorado River for calendar year 1961 was almost 400,000 acre-feet. During the first 12 months of operation of the Wellton-Mohawk drain (March 1961 through February 1962) about 175,000 acre-feet were returned to the river without much fluctuation in the quality of the drain water. Most of the individual samples and monthly averages showed between 8 and 9 tons of total dissolved solids per acre-foot, or about 6,000 to 6,500 ppm. Data available to date do not appear to indicate any downward trend in mineral content of the main drain discharge.

Chemical quality of the water from individual drainage wells in the Wellton-Mohawk covers a wide range. Some are as high as 17,000 ppm, although most are in the range of 4,800 to 7,200 ppm. (6.5 to 9.8 tons per acre-foot.)

Outflow from the Wellton-Mohawk drainage channel during the five-month winter period of 1961-62 was only 19 percent of the total flow at the boundary but the drain contributed 54 percent of the total salt load. Outflow from the drainage channel averages approximately 300 cfs or more than 40 percent of the minimum winter delivery schedule of about 700 cfs at Morelos Dam, allowing for the pumpage at San Luis and the waste returns from United States projects in the limitrophe section below Morelos. In October and November of 1961, the actual flow at the northerly boundary above Morelos averaged about 950 cfs, so that during those months the Wellton-Mohawk drainage discharge constituted nearly a third of the flow of the river. The following table shows a comparison for each of the five months, October 1961 through February 1962, of the flow and salt load of the Wellton-Mohawk drainage channel with the flow and salt load in the river at the northerly boundary.

	Wellton-Mohawk Drain		*Northerly boundary*	
Month	*Flow (acre-feet)*	*Salt (tons)*	*Flow (acre-feet)*	*Salt (tons)*
October 1961	18,630	158,700	59,270	199,700
November 1961	15,480	126,500	57,230	183,700
December 1961	10,690	85,900	81,720	230,400
January 1962	19,450	155,400	160,820	381,100
February 1962	16,260	134,500	67,540	226,300

In the preceding summer months the flow of the river had been of sufficient volume to dilute materially the highly saline discharges of the Wellton-Mohawk drainage channel. From March through September the discharge of the drain averaged only 7.5 percent of the total flow at the boundary, and the salt load about a third of the total. It was not until the fall and winter months, when the quantity of river water available for dilution was 60-75 percent less than in the summer, that the quality at the boundary deteriorated rapidly. The City of Yuma, as previously mentioned, reacted to the impact of the highly saline discharges more than a year earlier than did the Mexican irrigators.

Since drainage from the Wellton-Mohawk Unit appears to be the principal cause of the current problem, a provisional salt balance computation was made for that area. It indicates that about 2.9 million acre-feet of Colorado River water was diverted to the Wellton-Mohawk Unit between the date of first diversion in 1952 and the end of July 1962. That 10½-year inflow carried in about 3.1 million tons of salt. The salt was carried out in small amounts of return flow via the Gila River channel for all the 10½ years and in large amounts by the Wellton-Mohawk drain for about the last 1½ years. Estimates indicate that the salt output from the Wellton-Mohawk Unit during the 10½-year period was about 2.5 million tons. If the salt concentration in the drain stays at its current level throughout 1962, it appears that the total salt output in return flows will equal approximately the total Colorado River salt input for the 11-year period 1952-62, inclusive.

INVESTIGATIONS AND POSSIBLE SOLUTIONS

On March 16, 1962, the Presidents of the United States and Mexico instructed their representatives on the International Boundary and Water Commission to recommend remedial measures for the acute problem that arose during the preceding winter months. The stated objective was to put remedies into operation within the shortest possible time without prejudice to the legal rights of either country.

The United States Commissioner selected an advisory panel of five able and well-qualified soil and water experts, and the Mexican government appointed a similar panel. At the invitation of the United States Commissioner, a committee was formed of two representatives from each of the seven Colorado River Basin states to represent the basin's interests.

Possible solutions to the current acute situation have been suggested by various parties, ranging from a salt water conversion plant to a method of wasting the Wellton-Mohawk pump drainage into the desert where it could disappear. The suggestions most seriously considered include:

1. Installation of additional drainage wells in the Wellton-Mohawk area making it possible to pump at a lesser rate in winter than at present and a higher rate in summer when more river water is available for dilution;
2. Construction of a new conveyance channel that would bypass the Wellton-Mohawk drainage to a point on the river below the Mexican diversion structure.
3. Installation of a tile drainage system beneath the soils of the Wellton-Mohawk Project and cessation of the deep drainage pumping;

and various combinations of these three.

All the considered remedies involve engineering, economic, legal and political complications which militate against haste in devising a permanent solution to the overall problem.

Engineering problems include the collection and thorough analysis of considerably more field data than are now available, the conception of practical physical plans for comparison with one another, surveys and acquisition of rights-of-way, preparation of specifications, designs and cost estimates and execution of the necessary contracts and agreements. Economic problems include the proper allocation and repayment of the costs of facilities needed and the securing of funds to finance not only the construction of such facilities but their planning and design.

Investigations of physical solutions should include consideration of questions such as whether it would be practical from all standpoints to (a) maintain only a seasonal salt balance in the upper zone of the Wellton-Mohawk aquifer, leaving the bulk of the saline water now in the lower zones virtually undisturbed and unusable, (b) to dewater the entire aquifer and waste the effluent, and later to refill the underground formation with water of better quality as a standy and regulatory reserve, or (c) to freshen all the water in the aquifer gradually from the top down as the Wellton-Mohawk District intended by its present plan of drainage operation, and if so whether to expand the facilities to accomplish this quickly or to let it continue at its present rate.

The legal and political complications are local, regional, national and international in character and scope. Not to be overlooked are the extent and limit of the right of the Wellton-Mohawk Irrigation and Drainage District to operate its project facilities to best suit its own purposes, and the extent to which such operation as the District contemplates may be considered fair and reasonable to other interests including those in Mexico.

The Gila Project and the Wellton-Mohawk Division thereof are under statutory limitations as to the total annual beneficial consumptive use that can be made. For the Gila Project as a whole, the limitation is 600,000 acre-feet of net consumptive use per annum and for the Wellton-Mohawk Division, 300,000 acre-feet per annum. If the drainage from the Wellton-Mohawk Unit were to be so bypassed that it were not available for use elsewhere in the United States or in Mexico, it presumably could not be credited to the District as return flow under the statute or under the decree proposed by the Special Master in the pending Supreme Court suit, *Arizona v. California*. Similarly, if the Wellton-Mohawk aquifer were to be first dewatered of its present highly mineralized content and refilled with better water in a later period the larger diversions during the refilling period would not be offset by the return flow and the net diversions during that period, undoubtedly, would exceed the statutory limitation.

Representatives of the basin states and the United States government are agreed to stand upon the premise that the United States has no legal obligation under the Treaty to alleviate the current acute situation, but they also recognize that as a matter of international comity there may be a moral obligation and that as a practical matter the United States should do something. The question then arises as to whether anything can be done without establishing a precedent that would be prejudicial to the rights of the Colorado River Basin states under the Treaty. There are many different views, some conflicting, as to whether this can be done.

Officials of the Colorado River Basin states appear to be firmly unanimous in the position that whatever offer is made, if any, by the United States to help alleviate the situation at the boundary, it should be a part of the agreement with Mexico that Mexico itself and the farmers of the Mexicali Valley will undertake proper measures to improve irrigation and drainage facilities and practices in the Mexicali Valley and that remedial actions by the two countries should be concurrent.

United States interests are also unanimous that there should be no violation or modification of the provisions of the 1944 Water Treaty. The Mexican government apparently has not asked for modification of the terms of the Treaty. On April 1962, Governor Brown addressed a letter to Secretary of State Rusk urging that settlement should be considered which would involve an increase in the allotment

Mexico and stating that as developments proceed in the United States it will be increasingly important that the amounts and deliveries set out in the Mexican Water Treaty be firmly adhered to. Resolutions adopted by several bodies of the basin states and comments by state representatives at various times have strongly stated the view that nothing should be done which would result in a waste of water to the Gulf of California not charged to Mexico under the Treaty and thereby becoming an additional burden on the water supply of the Colorado River System. According to this view any drainage water from the United States projects that might be bypassed around Morelos Dam by an artificial channel should still be chargeable to Mexico in accordance with the Treaty schedules.

Evidently the United States and Mexican advisory panels have been unable to agree upon a solution for the problem at the boundary, or even upon a joint report. It is understood that the United States panel has submitted a unilateral report to the State Department, but the contents of the report have not been made public. It appears however that the Secretary of the Interior has been requested to undertake a comprehensive and intensive engineering investigation and study with the objective of devising, if possible, a plan of construction and operation of facilities that will effect a permanent solution to the water quality problem at the international boundary acceptable to all affected interests.

In the meantime the United States Commissioner of Reclamation has announced that by encroaching to a minor extent on the flood control reservation in Lake Mead during the month of April 1962, the Bureau has accumulated about 280,000 acre-feet of water which otherwise would have been wasted and which is committed to use during the winter months of 1962-1963 for much-needed channel control and rectification work on the Lower Colorado River. It was also stated that the necessary hydraulic sluicing and flushing could be co-ordinated with the low delivery schedules to Mexico and thus incidentally serve to dilute, to a usable salt concentration, the winter flows crossing the Mexican boundary. Details as to how this incidental benefit would be effected have not been furnished.

POSSIBLE FUTURE CONDITIONS

Water users in the international boundary area are at a distinct disadvantage because of their geographical location. By natural process alone, large quantities of minerals are dissolved and transported along the course of the Colorado River.

It is not unlikely that existing projects and projects now authorized may soon be utilizing all the available water supply of the Colorado River Basin. Future mainstream water reaching the Lower Colorado River area will have increased in salinity through more intensive use and additional pollution. Expert testimony in the pending Supreme Court suit, *Arizona* v. *California*, indicates that under future conditions of upstream development the salinity of the river at Imperial Dam may get as high as 1.50 tons per acre-foot and possibly more. Such probability is of serious concern to all Lower Basin mainstream water users because of the potential necessity of applying more water or reducing irrigated acreage in order to maintain favorable salt balance, and because of the provision in the Colorado River Compact that "perfected rights" shall be "unimpaired."

The problem of the Wellton-Mohawk Project and that at the Mexican border could become more aggravated also by the construction of the proposed Central Arizona Project. The planned diversion of about 1,200,000 acre-feet from the Colorado River to the Phoenix area probably would make it necessary to discharge quantities of salty water down the Gila River. In the 1947 report by the Commissioner of Reclamation on this proposed project it was estimated that if the project were constructed, the outflow from the project area for salt balance would amount to 376,000 acre-feet a year carrying nearly 2,100,000 tons of salt a year into the Lower Gila. The computation assumed that Colorado River water diverted into Central Arizona would carry an average salt load of about 1.1 tons per acre-foot. Expert testimony in *Arizona* v. *California* indicates that the future load in the Colorado River at the proposed point of diversion for the Central Arizona Project may be appreciably greater than assumed by the Bureau in 1947.

Much consideration should be given to the potential effect on water quality of any proposed future project to use Colorado River System water.

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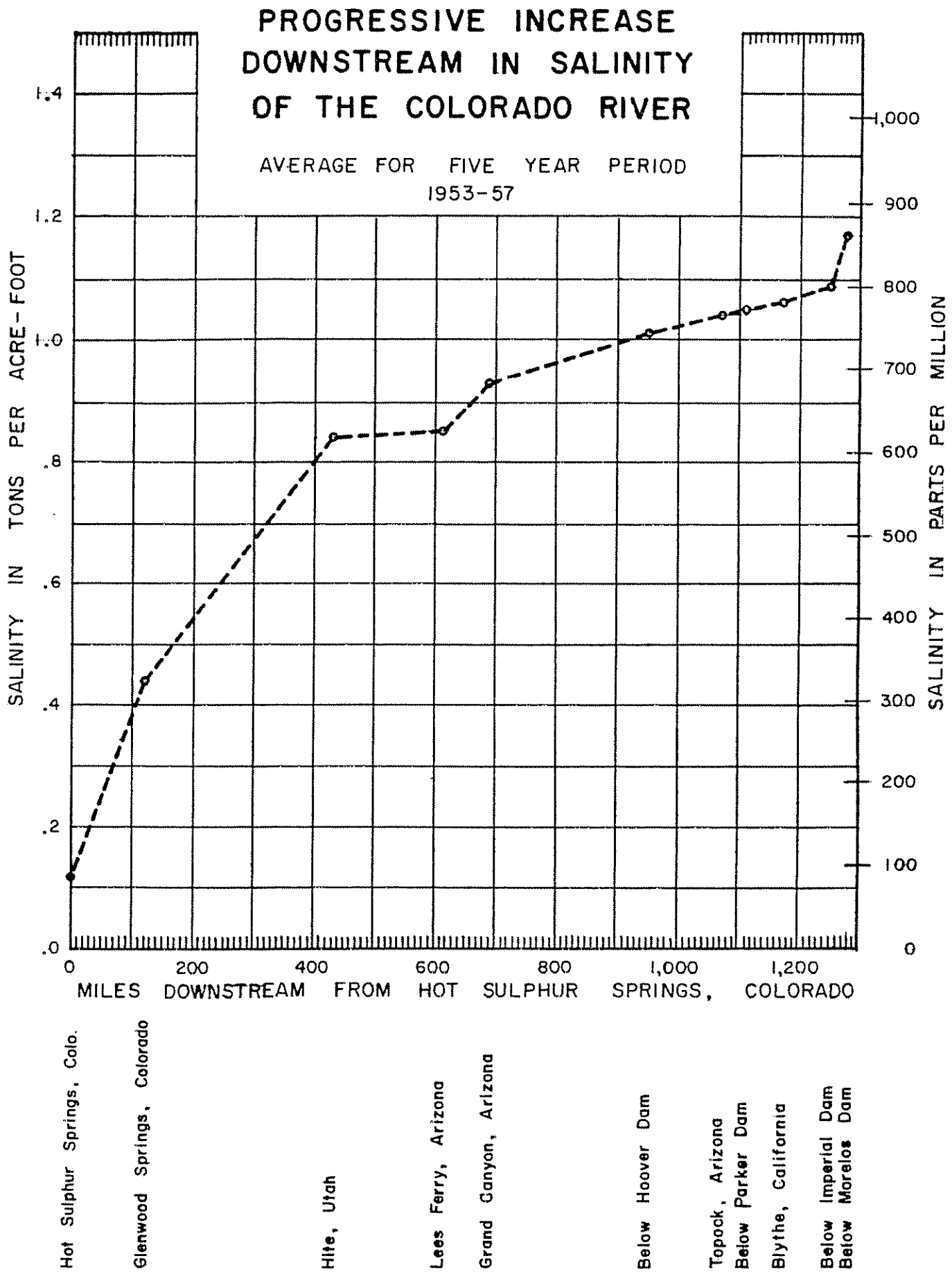
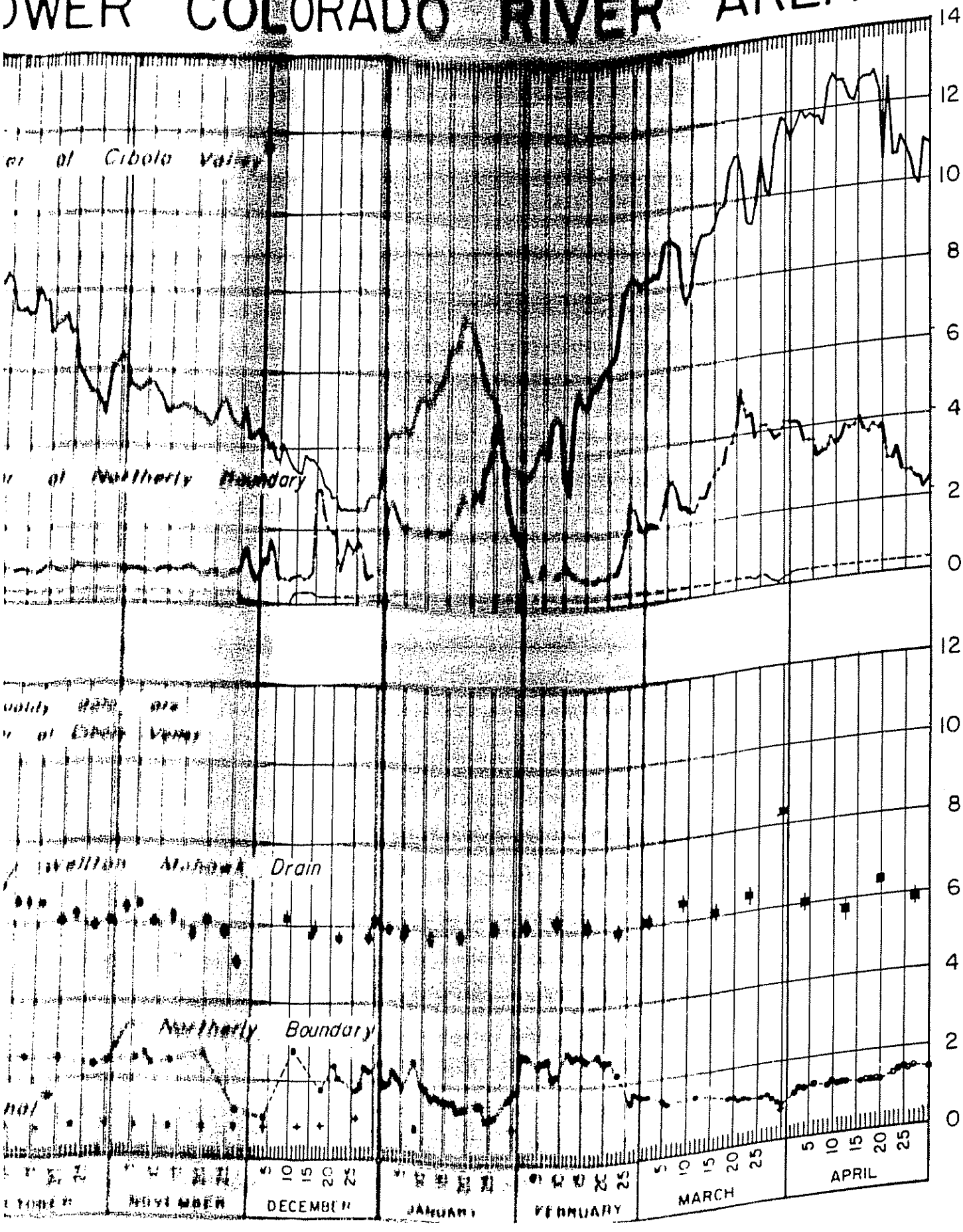

PROGRESSIVE INCREASE DOWNSTREAM IN SALINITY OF THE COLORADO RIVER
AVERAGE FOR FIVE YEAR PERIOD 1953-57
SALINITY IN TONS PER ACRE-FOOT
SALINITY IN PARTS PER MILLION
1.4
1.2
1.0
.8
.6
.4
.2
.0
1,000
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1,000
1,200
MILES DOWNSTREAM FROM HOT SULPHUR SPRINGS, COLORADO
Hot Sulphur Springs, Colo.
Glenwood Springs, Colorado
Hite, Utah
Lees Ferry, Arizona
Grand Canyon, Arizona
Below Hoover Dam
Topock, Arizona
Below Parker Dam
Blythe, California
Below Imperial Dam
Below Morelos Dam

)WER COLORADO RIVER AREA



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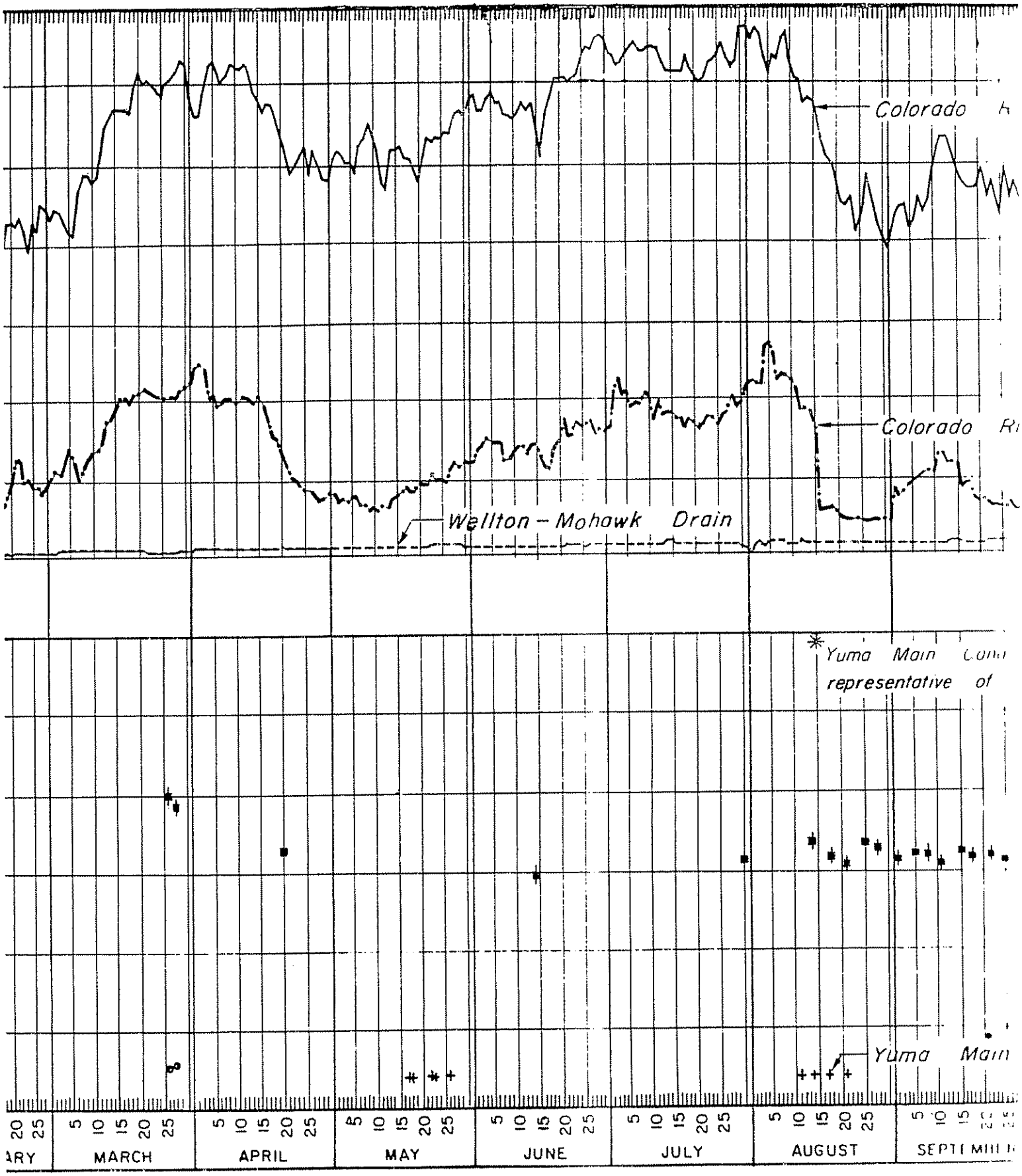
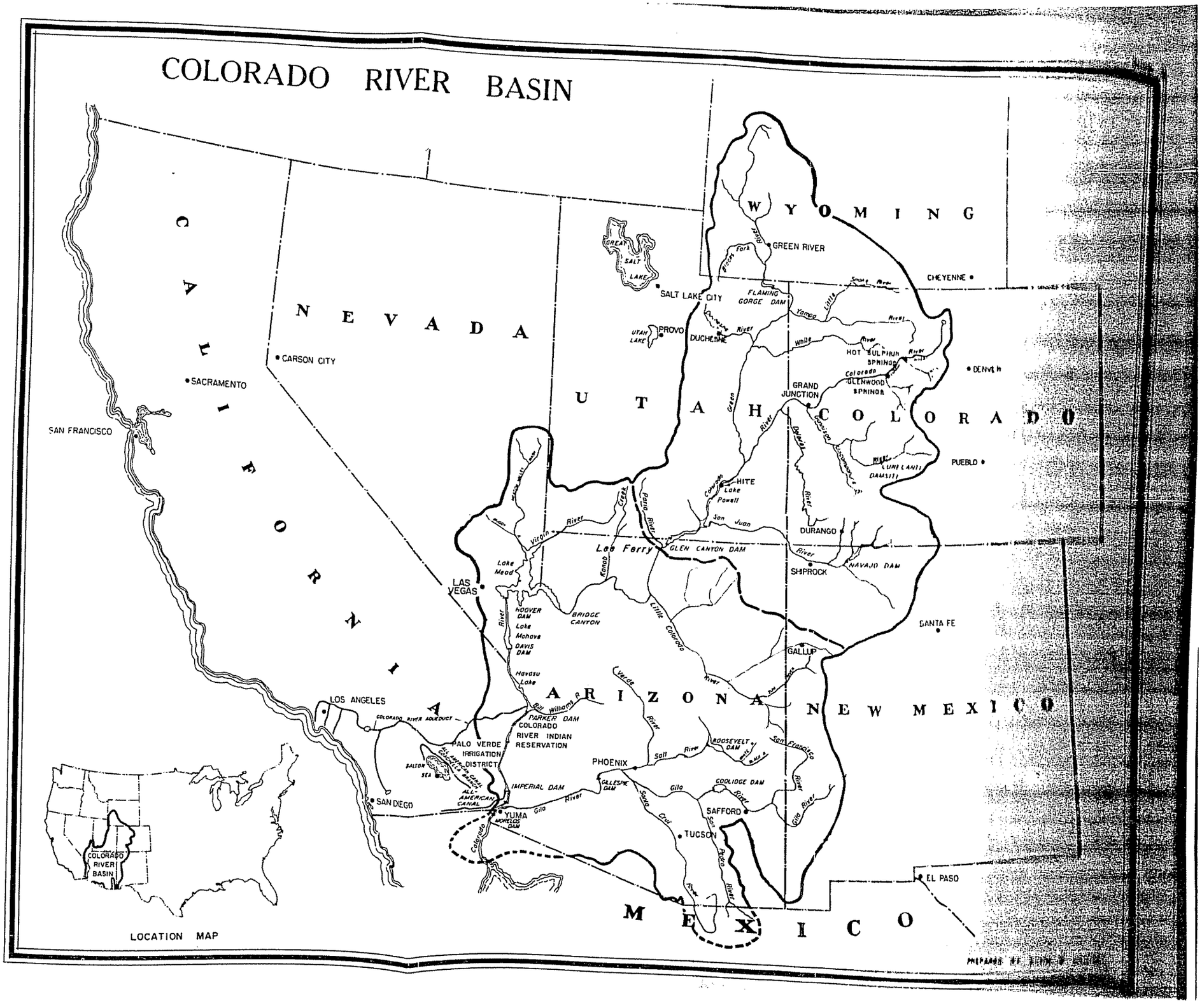
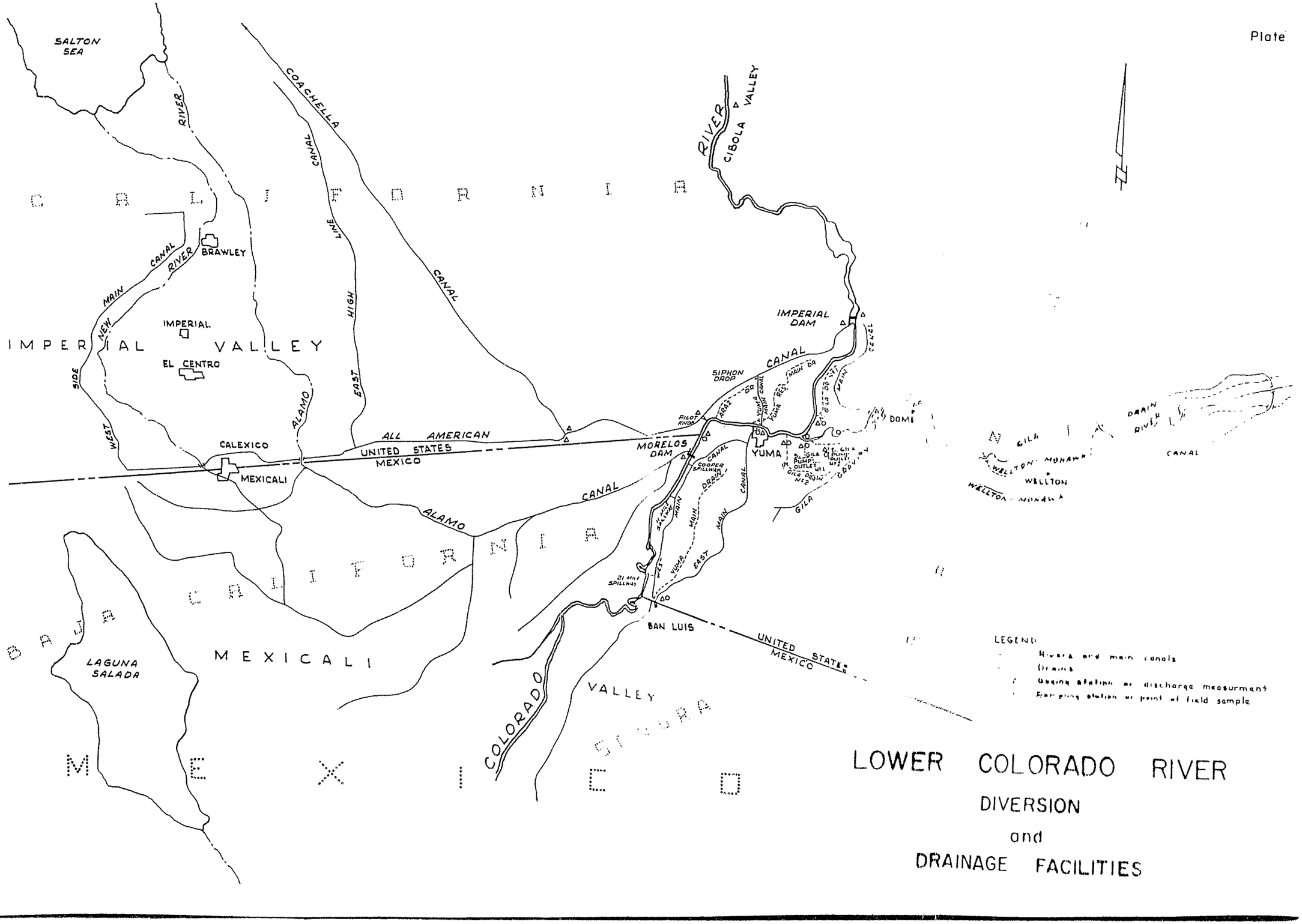


1961

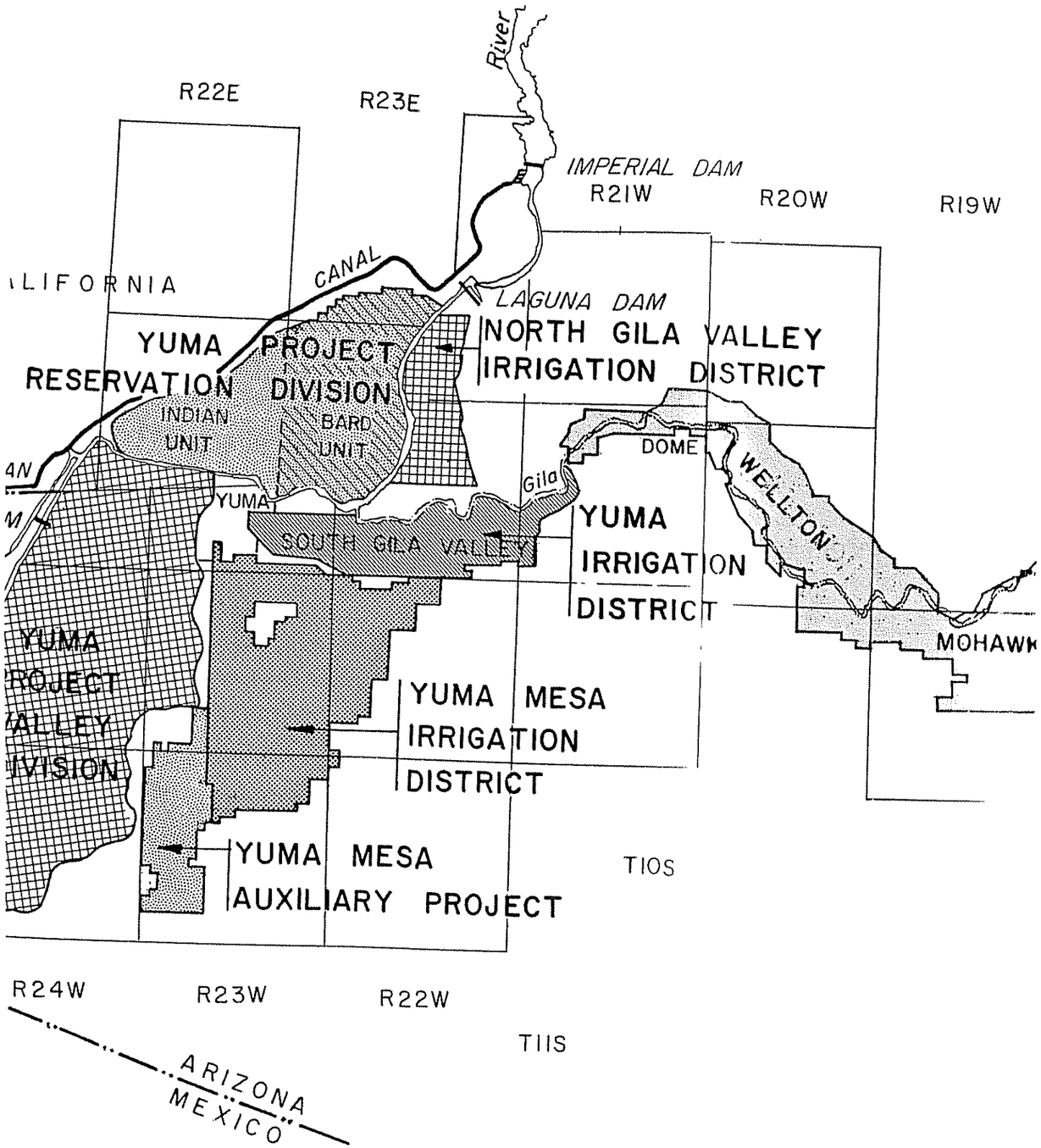
COLORADO RIVER BASIN

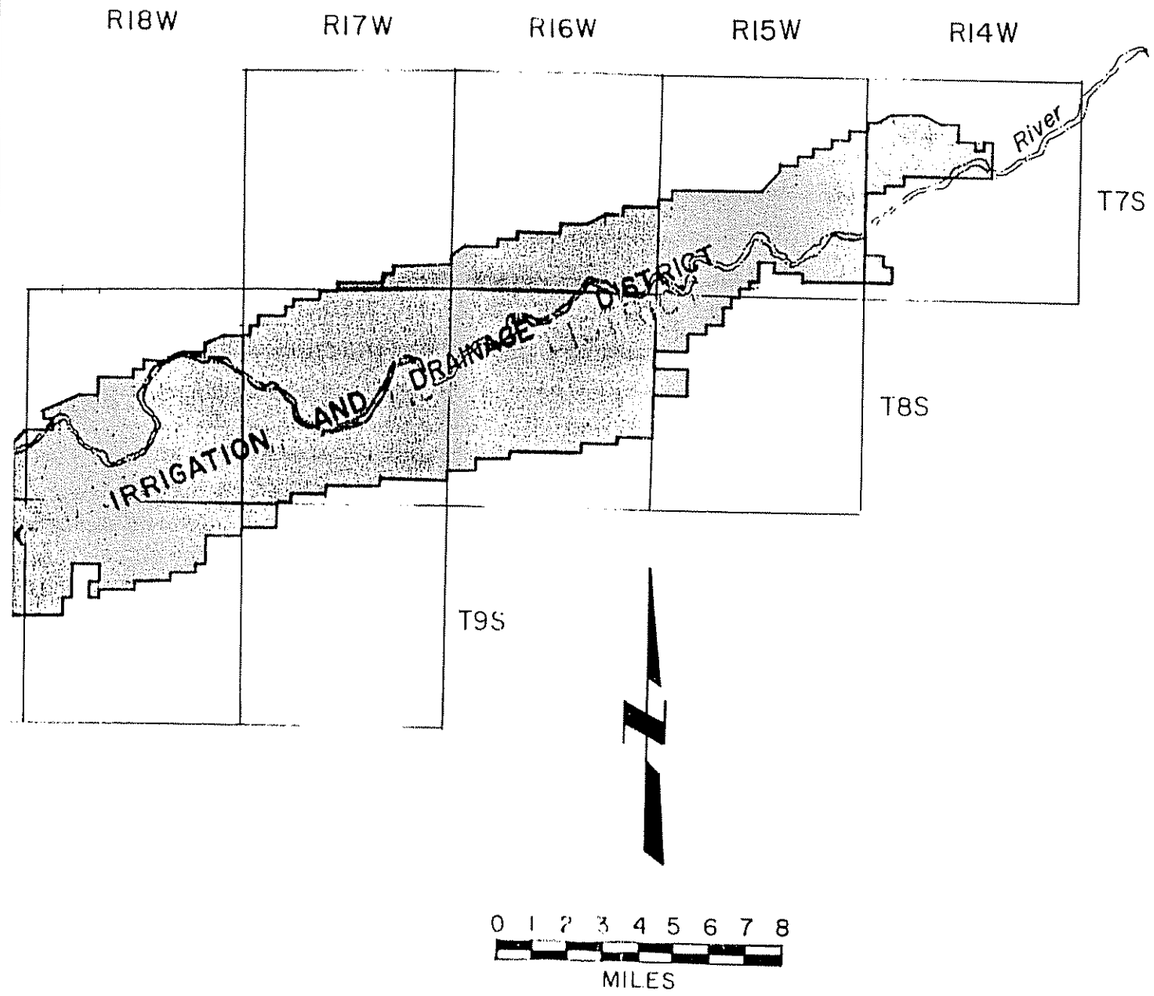


Plate

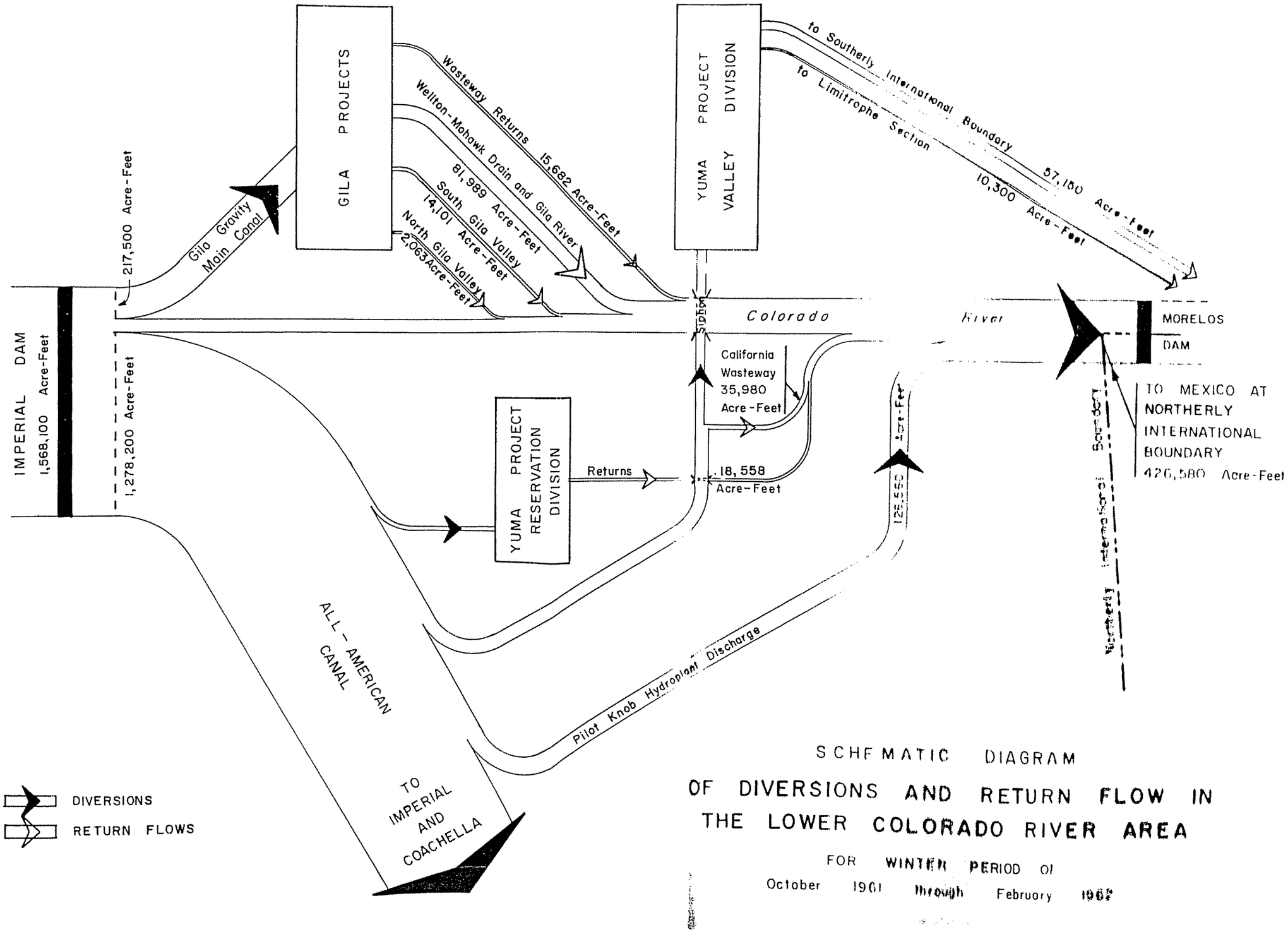


LOWER COLORADO RIVER
DIVERSION
and
DRAINAGE FACILITIES





IRRIGATION PROJECTS IN THE YUMA AREA



SCHEMATIC DIAGRAM

OF DIVERSIONS AND RETURN FLOW IN THE LOWER COLORADO RIVER AREA

FOR WINTER PERIOD OF

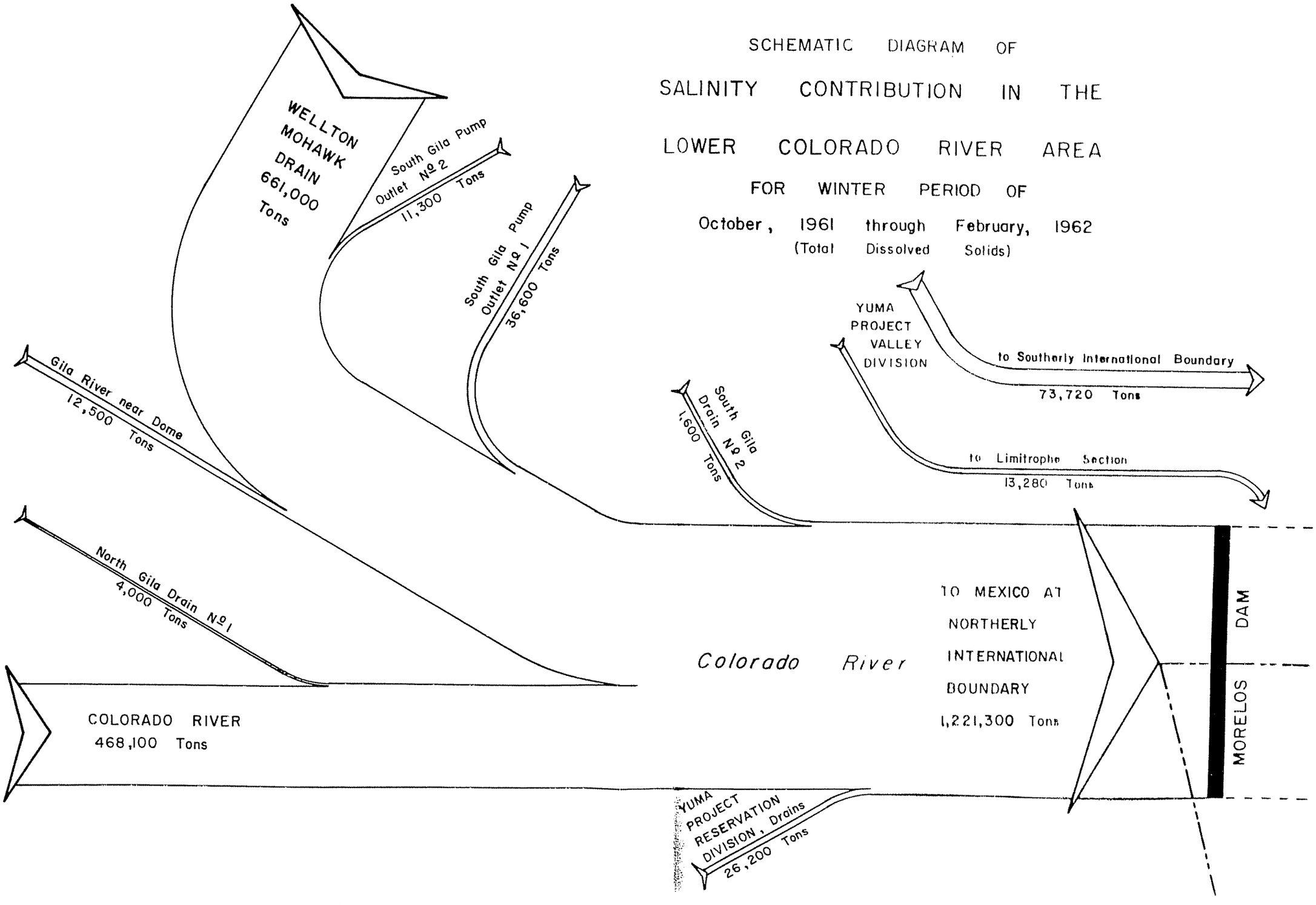
October 1961 through February 1962

SCHEMATIC DIAGRAM OF SALINITY CONTRIBUTION IN THE LOWER COLORADO RIVER AREA

FOR WINTER PERIOD OF

October, 1961 through February, 1962

(Total Dissolved Solids)



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July 1984

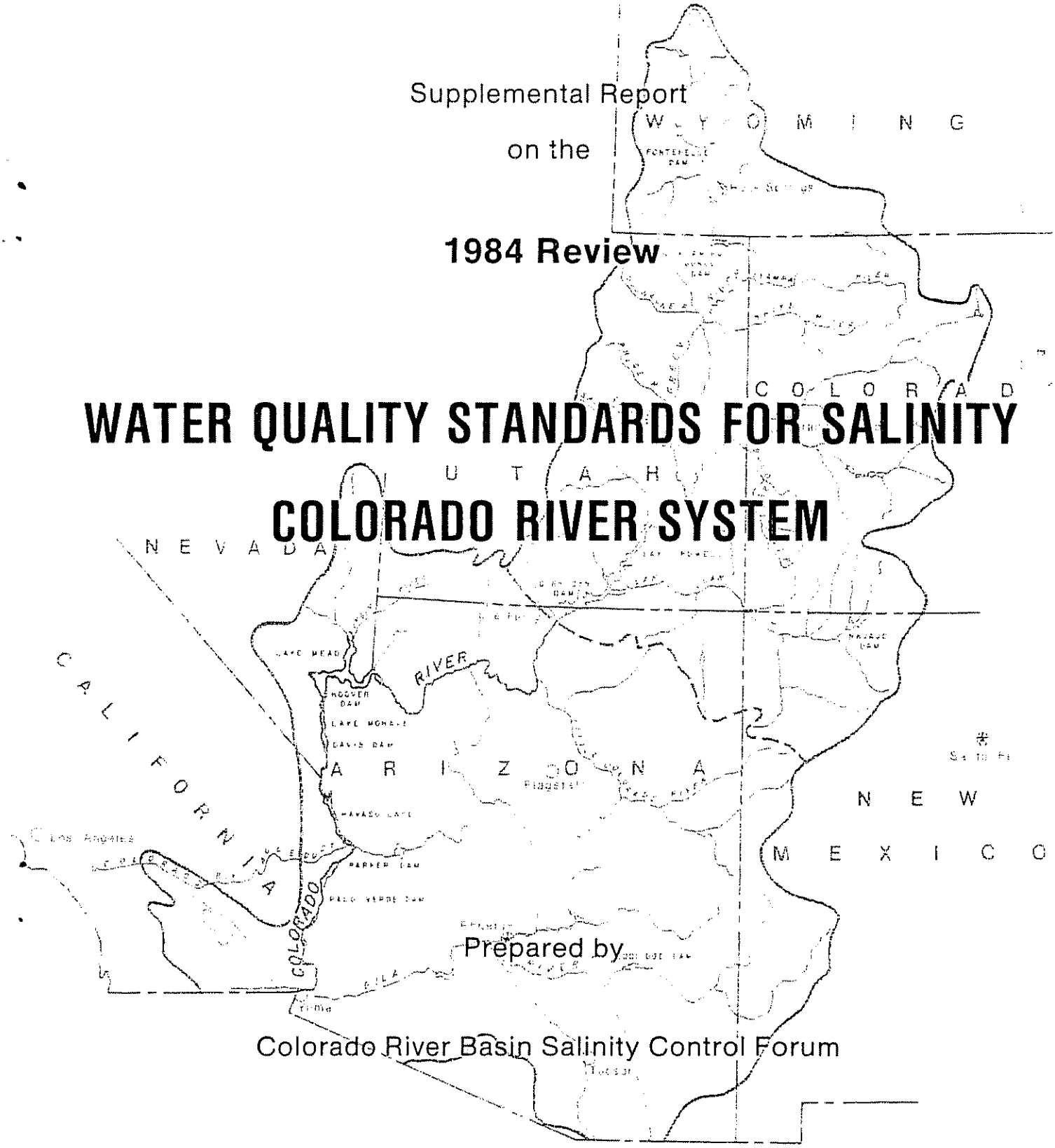
Supplemental Report

on the

1984 Review

WATER QUALITY STANDARDS FOR SALINITY

COLORADO RIVER SYSTEM



Prepared by

Colorado River Basin Salinity Control Forum

July 1984

Supplemental Report

on the

1984 Review

WATER QUALITY STANDARDS FOR SALINITY

COLORADO RIVER SYSTEM

Prepared by

Colorado River Basin Salinity Control Forum

COLORADO RIVER BASIN SALINITY CONTROL FORUM

MEMBERS

ARIZONA

Wesley Steiner, Director
Department of Water Resources

Dr. Ronald Miller, Acting Assistant Director
Department of Environmental Health

Stewart Udall, Attorney at Law, Member
Central Arizona Water Conservation District

CALIFORNIA

Myron B. Holburt, Assistant General Manager
The Metropolitan Water District of Southern California

Walter Pettit, Deputy Executive Director
State Water Resources Control Board

COLORADO

David H. Getches, Executive Director
Department of Natural Resources

Robert Arnott, Assistant Director
Department of Health

David Robbins, Attorney at Law

NEVADA

Jack L. Stonehocker, Director
Colorado River Commission of Nevada

Lewis H. Dodgion, Administrator
Division of Environmental Protection

Roland D. Westergard, Director
Department of Conservation and Natural Resources

NEW MEXICO

Stephen E. Reynolds, State Engineer

UTAH

Daniel F. Lawrence, Director
Division of Water Resources

Calvin K. Sudweeks, Director
Bureau of Water Pollution Control
Division of Environmental Health

WYOMING

George L. Christopulos, State Engineer

William F. Garland, Administrator
Department of Environmental Quality

Jack A. Barnett, Executive Director
Colorado River Basin Salinity Control Forum
106 West 500 South, Suite 101
Bountiful, Utah 84010

CONTENTS

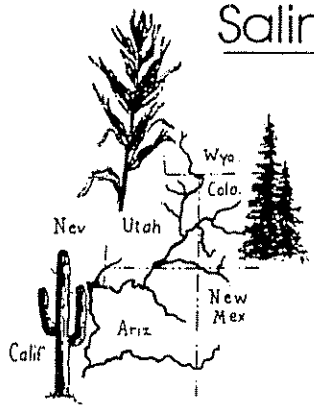
TRANSMITTAL LETTERS

The Federal Water Pollution Control Act requires that at least once every three years the states of the Colorado River Basin review water quality standards relating to the salinity of the waters of the Colorado River. The states collectively initiate this review under the aus pices of the Colorado River Basin Salinity Control Forum and prepare a proposed report and a supplemental report.

Upon the Forum's adoption of these two reports, they are transmitted to the individual states for their own independent action. The following is a copy of the transmittal letter to the State of Arizona. Following Arizona's transmittal letter is a listing of the recipients in each of the states of an identical letter.

Colorado River Basin

Salinity Control Forum



Honorable Bruce Babbitt
Governor of Arizona
Statehouse
Phoenix, Arizona 85007

Dear Governor Babbitt:

Enclosed is a copy of the report "1984 Review Water Quality Standards for Salinity, Colorado River System", approved on May 1, 1984, by the seven state Colorado River Basin Salinity Control Forum.

Subsequent to the May approval, two regional public meetings were held to provide an opportunity for those who so desired to present comments or suggestions on the proposed report. The meetings were held on June 25, 1984, in Rock Springs, Wyoming, and June 27, 1984, in Las Vegas, Nevada. A supplement, including modifications to the report based on comments and suggestions received, is also enclosed. The attached supplement was approved by the Forum on July 25, 1984. The report and the supplement constitute the 1984 review of the Colorado River salinity standards.

Section 303(c)(1) of the Clean Water Act requires that:

> The Governor of a State or the State water pollution control agency of such State shall from time to time (but at least once each three year period beginning with the date of enactment of the Federal Water Pollution Control Act Amendments of 1972) hold public hearings for the purpose of reviewing applicable water quality standards and, as appropriate, modifying and adopting standards. Results of such review shall be made available to the Administrator.

106 West 500 South, Suite 101
Bountiful, Utah 84010
(801) 292-4663

The enclosed report and its supplement recommends no change in the numeric criteria for salinity but reflects some changes in the plan of implementation previously adopted by the Forum. The Forum urges that each state water control agency adopt the 1984 Review as appropriate, thus preserving the basin-wide approach to salinity control developed by the basin states over the last decade. The Forum urges that your State take prompt action in adopting this review.

Sincerely,

David Robbins
Chairman

Enclosure

cc: Arizona Forum Members

Identical transmittal letter sent to each of the following:

Honorable George Deukmejian
Governor of California
State Capitol
Sacramento, California 95814

Honorable Richard D. Lamm
Governor of Colorado
State Capitol
Denver, Colorado 80203

Honorable Richard Bryan
Governor of Nevada
State Capitol
Carson City, Nevada 89701

Honorable Toney Anaya
Governor of New Mexico
State Capitol
Santa Fe, New Mexico 87501

Honorable Scott M. Matheson
Governor of Utah
State Capitol
Salt Lake City, Utah 84114

Honorable Ed Herschler
Governor of Wyoming
State Capitol
Cheyenne, Wyoming 82001

INTRODUCTION

This supplement to the 1984 Review - Water Quality Standards for Salinity contains statements and comments received by the Forum and the Forum's response. Statements and comments were received at public meetings held in Rock Springs, Wyoming on June 25, 1984, and in Las Vegas, Nevada on June 27, 1984. Written comments received by June 30, 1984 were also accepted. The supplement also includes the correction of typographical errors. Each comment or statement received is presented followed by the Forum's response.

STATEMENTS, COMMENTS AND FORUM RESPONSES

STATE OF CALIFORNIA—RESOURCES AGENCY GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF WATER RESOURCES
P.O. Box 6598
LOS ANGELES
90055

JUN 2 7 1984

Colorado River Basin
Salinity Control Forum
106 West 500 South, Suite 101
Bountiful, Utah 84010

Attention: Mr. Jack A. Barnett
Executive Director

As requested in the June 7, 1984, letter to the Department from the Colorado River Basin Salinity Control Forum, we have reviewed the "Proposed Report on the 1984 Review - Water Quality Standards for Salinity Colorado River System". We find the report to be comprehensive and informative.

We support the Forum's plan of retaining the salinity numeric criteria, and continuing to use them during the next three-year period. These numeric criteria consist of total dissolved solids concentrations for the Colorado River of:

Below Hoover Dam	723 mg/L
Below Parker Dam	747 mg/L
Imperial Dam	879 mg/L

Concerning the LaVerkin Springs Unit (page 47) and the diversion of saline waters from these springs into evaporation ponds, we question the use of clay liners. Because of the potential for base exchange between saline waters and clays, the integrity of the liners could be threatened. Therefore careful consideration should be given to selecting the appropriate type of liner material to mitigate this potential problem.

For further information, you may wish to contact Sanford L. Werner at (213) 620-4836.

Sincerely,

C B Arnold

Jack J. Coe, Chief
Southern District

RESPONSE

As stated in the report, additional studies were made to evaluate clay lining in the LaVerkin Springs Unit. Those studies considered all aspects of pond lining, however, it was found that the use of clay liners or membrane liners did make the unit cost-effective. Therefore, further investigation of the LaVerkin Springs Salinity Control Unit has been discontinued at this time.

COMMENT FROM DR. LARRY PAULSON, PROFESSOR,
UNIVERSITY OF NEVADA LAS VEGAS

Dr. Paulson suggested that the Forum include in the supplement a comparison of the salinity projections made in 1972 with the salinity concentrations measured in the lower main stem subsequent to 1972.

RESPONSE

Such comparison and analyses are regularly being made by the Forum and the Bureau of Reclamation. As a result, continuous refinements are being made in the assumptions, data base, simulation system, and salinity projections. During the 1978 Review, the Forum recognized that measured salinity concentrations were not following the earlier projections. The Forum addressed this question in the 1978 Review and in more detail in the 1981 Review. Early indications were that the salt load entering the river was overestimated. In the 1981 Review, the Forum evaluated the inflow to Lake Powell, inflow from Lees Ferry to Grand Canyon, salt gain or loss in Lake Powell, and bank storage in Lake Powell. Based on the above evaluation, the salt load estimate was revised for the salinity projections used in the 1981 Review. The Forum continued this process for the 1984 Review and again revised its salinity projections. Research and evaluation is continuing by the Forum and Reclamation to

develop a higher level of confidence in the simulation system and resulting projections. Bureau of Reclamation Commissioner Robert Olson's statement describes the recent research activities of that agency.

Because of the ongoing process, a comparison of the salinity projections made in 1972 with the salinity concentrations measured in the lower main stem subsequent to 1972 would be of relatively little value.

COMMENT

It was brought to the Forum's attention that the 1977 "Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program" and the 1980 "Policy for Use of Brackish and/or Saline Waters for Industrial Purposes" are included only by reference in the 1984 Review. It was suggested that, for the convenience of each state in its review process, and those persons who do not have copies of the earlier three year reviews that the above policies be included in this supplement.

RESPONSES

The Forum agrees. The policies are included in this supplement.

ADDITIONAL STATEMENTS

A number of agencies submitted statements supporting the report and made no recommendations for changes. The agencies are: Imperial Irrigation District, San Diego County Water Authority, Palo Verde Irrigation District, Coachella Valley Water District, The Metropolitan Water District of Southern California, Los Angeles Department of Water and Power, Colorado River Board of California, Bureau of Reclamation, Soil Conservation Service, and the International Boundary and Water Commission.

TELEPHONE 619 339 9200

IMPERIAL IRRIGATION DISTRICT

OPERATING HEADQUARTERS • IMPERIAL, CALIFORNIA 92251

IIDGM

June 20, 1984

Mr. Jack A. Barnett
Colorado River Basin Salinity
Control Forum
106 West 500 South, Suite 101
Bountiful, UT 84010

Dear Mr. Barnett:

Imperial Irrigation District, being one of the major beneficiaries of salinity control and being subject to damages due to adverse effects of salinity, is in full support of the Colorado River Basin Salinity Control Forum in its efforts to control salinity in the Lower Colorado River region.

The Department of the Interior and Department of Agriculture projects which are designed to maintain the numeric salinity criteria in the Lower Colorado River should be carried out expediently, particularly the completion of construction of Paradox Valley and Grand Valley Salinity Control Units.

To summarize, we have examined the proposed report on the "1984 Review - Water Quality Standards for Salinity - Colorado River System" and agree with its content. This District is eager to see the various facets of these criteria maintained.

Yours truly,

CHARLES L. SHREVES
General Manager

San Diego County Water Authority

2750 Fourth Avenue, San Diego, California 92103 (619) 297-3218

(A Public Agency Organized June 9 1944)

June 20, 1984

Mr. Jack A. Barnett
Executive Director
Colorado River Basin Salinity
Control Forum
106 West 500 South, Suite 101
Bountiful, Utah 84010

Dear Mr. Barnett:

The San Diego County Water Authority agrees with the recommendations of the Forum as described in its proposed report on the "1984 Review-Water Quality Standards for Salinity, Colorado River System". We see no reason to recommend changes in the numeric salinity criteria for the "Below Hoover Dam", "Below Parker Dam", and "Imperial Dam" stations.

We concur that the described plan of implementation should be carried out, especially the completion of construction of the Paradox Valley and Grand Valley Units listed in Section 202, Title II of Public Law 93-320. Further, we believe that work should proceed with the other Departments of the Interior and Agriculture projects described in the plan of implementation.

Please have this letter introduced in the hearing scheduled for Wednesday, June 27, 1984 in Las Vegas.

Very truly yours,

Lawrence R Michaels

Lawrence R. Michaels
General Manager and Chief Engineer

LRM: jmr

120,500 ACRES LOCATED ALONG COLORADO RIVER

PALO VERDE IRRIGATION DISTRICT

Office Address
180 West 14th Avenue
Blythe, California

Mailing Address
P.O. Box 1199
Blythe, California 92226

Telephone (714) 922-3144

June 20, 1984

Mr. Jack A. Barnett, Executive Director
Colorado River Basin
Salinity Control Forum
106 West 500 South, Suite 100
Bountiful UT 84010

Dear Mr. Barnett:

The Palo Verde Irrigation District concurs with the 1984 Review and recommended revisions of the "Water Quality Standards for Salinity - Colorado River System", May 1984, as prepared by the Colorado River Basin Salinity Control Forum.

Yours very truly,
PALO VERDE IRRIGATION DISTRICT

Virgil L. Jones

VLJ/elc

ESTABLISHED IN 1918 AS A PUBLIC AGENCY

COACHELLA VALLEY WATER DISTRICT

POST OFFICE BOX 1058 • COACHELLA, CALIFORNIA 92236 • TELEPHONE (714) 398-2651

DIRECTORS
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TELLIS CODEKAS, VICE PRESIDENT
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PAUL W. NICHOLS
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OFFICERS
LOWELL O. WEEKS, GENERAL MANAGER—CHIEF ENGINEER
BERNARDINE SUTTON, SECRETARY
VICTOR B. HARDY, AUDITOR
REDWINE AND SHERRILL, ATTORNEYS

June 18, 1984

Jack A. Barnett
Executive Director
Colorado River Basin Salinity Control Forum
106 West 500 South, Suite 101
Bountiful, Utah 84010

Dear Mr. Barnett:

Subject: 1984 Review of Water Quality Standards of Salinity for the Colorado River System

The Coachella Valley Water District concurs with the seven state Colorado River Basin Salinity Control Forum's findings, particularly with regard to the numeric salinity criteria and plan of implementation for salinity control for the Colorado River system. We see no reason to recommend changes in the numeric salinity criteria.

The plan of implementation is endorsed by this District.

Yours very truly,

Lowell O. Weeks
General Manager-Chief Engineer

LOW:bas

The Metropolitan Water District of Southern California

Office of the General Manager

June 18, 1984

Mr. Jack A. Barnett
Executive Director
Colorado River Basin Salinity
Control Forum
106 West 500 South, Suite 101
Bountiful, Utah 84010

Dear Mr. Barnett:

Report on the
1984 Review of the Colorado River Salinity
Standards and Implementation Plan

We have reviewed the proposed report on the 1984 Review of the Colorado River salinity standards and implementation plan. The Metropolitan Water District of Southern California wishes to commend the Colorado River Basin Salinity Control Forum on its continuing efforts regarding salinity control. The Forum's efforts in maintaining interstate cooperation and support for the program, and its overall coordination and ongoing monitoring of salinity changes and program effectiveness are also to be commended.

The District is pleased to see that more attention is being given to control of the largest man-made source, irrigated agriculture. The on-farm salinity control measures appear to be one of the most cost-effective means of maintaining the numeric criteria.

The Metropolitan Water District appreciates this opportunity to comment on the Forum's 1984 Review report. We endorse the report and its recommendations for the salinity standards and the plan of implementation, and we urge their adoption by each of the concerned states.

Very truly yours,

Carl Boronkay

Carl Boronkay
General Manager

MBH/ub

1111 Sunset Boulevard, Los Angeles, Calif. / Mailing address: Box 54153, Los Angeles, Calif. 90054 / Telephone: (213) 250-6000

Department of Water and Power the City of Los Angeles

TOM BRADLEY
Mayor

Commission
JACK W. LEENEY, *President*
RICARDO R. GUTIERREZ, *Vice President*
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NORMAN E. NICHOLS, *Chief Electrical Engineer and Assistant Manager*
DUANE L. GEORGESON, *Chief Engineer of Water Works and Assistant Manager*
NORMAN J. POWERS, *Chief Financial Officer*

June 25, 1984

Mr. Jack A. Barnett
Executive Director
Colorado River Basin Salinity
Control Forum
106 West 500 South, Suite 101
Bountiful, Utah 84010

Dear Mr. Barnett:

Proposed Report on the 1984 Review -
Water Quality Standards for Salinity
Colorado River System

This is in response to the June 7, 1984 invitation by the California members of the Colorado River Basin Salinity Control Forum to make comments and suggestions on the above titled report. We are in general agreement with all points covered in the report and support the report's recommendations.

Of particular importance are the recommendations to expedite completion of two salinity control units, the Paradox Valley and Grand Valley Units, authorized by Section 202, Title II, of Public Law 93-320, the Colorado River Basin Salinity Control Act. In addition, we support the implementation of the Department of the Interior and Department of Agriculture salinity control projects described in the plan of implementation. We believe these salinity control units are essential in minimizing the salinity of the Colorado River and in making a better quality water available for delivery to the City of Los Angeles and other users of Metropolitan Water District's water supply in the future.

We appreciate the opportunity to review and comment upon the report.

Sincerely,

Duane L. Georgeson /pf

DUANE L. GEORGESON
Assistant General Manager - Water

cc: Vernon E. Valantine

111 North Hope Street, Los Angeles, California ☐ *Mailing address*: Box 111, Los Angeles 90051
Telephone: (213) 481-4211 *Cable address*: DEWAPOLA

R E S O L U T I O N

of

COLORADO RIVER BOARD OF CALIFORNIA

in Support of the

1984 Review, Water Quality Standards for Salinity,

Colorado River System

WHEREAS, the salinity of the Colorado River is of great concern to the nearly thirteen million people in California who rely in full or in part on water from the river and to those who farm over 650,000 acres of irrigated lands; and

WHEREAS, water quality standards for salinity, including numeric criteria and a plan of implementation, were established by the seven-state Colorado River Basin Salinity Control Forum in 1975, adopted by the seven Basin states, and approved by the Environmental Protection Agency as a basinwide approach to controlling salinity in the Colorado River; and

WHEREAS, Section 303 of the Clean Water Act of 1977 requires that the water quality standards be reviewed from time to time, but at least once during each 3-year period; and

WHEREAS, pursuant to Section 303 of the Clean Water Act, reviews of the Colorado River water quality standards for salinity were conducted in 1978 and 1981, wherein it was found that the 1975 numeric criteria were still appropriate and wherein the plan of implementation was reviewed and modified to accommodate changes; and

WHEREAS, the proposed Colorado River Salinity Control Forum's 1984 review of the water quality standards for salinity recommends that no changes be made in the 1975 numeric criteria but that the plan of implementation be modified to reflect changes since 1981; and

WHEREAS, there is no reason to believe that the numeric criteria will be exceeded during the next 3-year review period;

NOW, THEREFORE, BE IT RESOLVED that the Colorado River Board of California fully supports the proposed 1984 Review, Water Quality Standards for Salinity, Colorado River System.

Unanimously adopted June 13, 1984

State of California)
) ss
County of Los Angeles)

I, DENNIS B. UNDERWOOD, Executive Secretary of the Colorado River Board of California, do hereby certify that the foregoing is a true copy of a resolution adopted by said Board at a Regular Meeting thereof, duly convened and held in Los Angeles, California, on the 13th day of June 1984, at which a quorum of said Board was present and acting throughout.

Dated this 13th day of June 1984.

DENNIS B. UNDERWOOD
Executive Secretary

STATEMENT ON BEHALF OF ROBERT L. OLSON, ACTING COMMISSIONER, BUREAU OF RECLAMATION, FOR PRESENTATION BEFORE THE PUBLIC MEETING RELATING TO THE PROPOSED 1984 REVIEW - WATER QUALITY STANDARDS FOR SALINITY IN THE COLORADO RIVER SYSTEM - ROCK SPRINGS, WYOMING, JUNE 25, 1984, AND LAS VEGAS, NEVADA, JUNE 27, 1984.

Colorado River salinity standards are of special importance to the Department of the Interior and the Bureau of Reclamation. We are charged with planning and constructing many of the principal physical components of the plan of implementation to maintain the adopted standards for the Colorado River System. Thus, the standards have a direct bearing on Reclamation's particular share of responsibilities associated with development and management of the water resources of the Colorado River Basin.

The Bureau of Reclamation endorsed the salinity standards proposed by the Colorado River Basin Salinity Control Forum, adopted by the Basin States, and approved by the Environmental Protection Agency in 1975. We have been continuously kept informed of the progress of the Forum during the current review of the water quality standards. We appreciate having had the opportunity to work with the Forum in this endeavor.

We believe the Forum's approach of considering the total basin as a single operating entity is the most logical and workable method to meet the overall objective of maintaining salinity levels in the lower main stem at or below 1972 levels, while water resource development continues throughout the Basin. Our own independent analyses support the Forum's conclusion that salinity levels at the three numeric criteria stations will not exceed the 1975 criteria (i.e., 1972 salinity levels) or the proposed 1984 criteria during the next 3 years. In the long term, the Forum salinity projections appear reasonable for the assumptions made.

A one-year Reclamation study to determine long-term trends and salinity streamflow relationships was completed in 1984. The effect of construction of major reservoirs on ion concentration was evaluated, and a theoretical model for describing ion concentration/streamflow relationships was developed and tested. This study demonstrated that there appears to be no major long term trends in the total salt load of the system, but rather that the apparent shifts are related to time delays in the reservoir system.

Another research study performed under contract to Reclamation involved development of a two-dimensional research model to predict changes in temperature and salinity concentrations, and associated salt precipitation in Lake Powell and Lake Mead. This model will increase the reliability of long-range salinity projections. This study showed that the maximum amount of salt precipitation that may be expected in Lakes Powell and Mead is on the order of 50,000 tons, or less than 1 percent of the throughput.

Reclamation activities associated with the plan of implementation for meeting Colorado River salinity standards include the construction of two authorized projects, feasibility studies leading to possible authorization and construction of 10 additional salinity control units, advance planning on the authorized Las Vegas Wash Unit, and steps to encourage beneficial industrial use of saline and/or brackish waters.

We are making significant progress on construction of the Grand Valley salinity control unit. Construction of Stage One is substantially complete. Monitoring continues on the Stage One laterals for flow fluctuations and associated operational problems. The moss and debris removal structure was installed in 1983, approximately one year ahead of schedule. Monitoring of the Stage One area has shown a reduction in salt load for 1983 of 15,600 tons, of which 14,200 was related to the canal and lateral lining and 1,400 tons to the USDA onfarm program. A recommended plan has been identified in the Stage Two draft supplement to the Definite Plan Report. This plan would reduce salinity concentration at Imperial Dam by 14.6 mg/L and result in an overall cost-effectiveness of $766,000 per mg/L reduction at Imperial Dam. The draft Environmental Statement is scheduled for completion in mid-1985.

Paradox Valley salinity control unit has suffered delays in developing the deep well injection plan. Information obtained by the deep well drilling consultant resulted in a decision not to attempt rehabilitation of the abandoned Conoco Well in Paradox Valley. This change necessitated revising the deep well drilling specifications and delayed the contract award until early in 1985.

In the Las Vegas Wash Unit, a contract was awarded to construct the 3.5 mile Pittman bypass pipeline with the completion date established for November 28, 1984. Pending verification, it appears a cost-effective strategy using ground water barriers in other areas of the Wash may be viable for further reductions. A verification effort has been proposed to test the ground water barrier concept with a monitoring program to assess results.

In recent years, feasibility investigations under the Colorado River Water Quality Improvement Program have been continuing essentially on schedule. Advance planning studies are in progress on the Lower Gunnison Basin Unit, under the two-stage planning process, and an advance planning study is planned for the Big Sandy River Unit in FY 85. Advance planning can begin on three others when funding becomes available. Recommendations have been made to suspend studies on the LaVerkin Springs Unit studies because of limited salinity control opportunity and high costs. The Glenwood-Dotsero Springs Unit studies are nearing completion and further studies will begin when an industrial use option is identified.

The Saline Water Use and Disposal Opportunities Unit involves the

study of Aquatrain, a proposed pipeline system to divert water from saline point and diffuse sources to industrial uses and to transport coal and other products from mines to points of use. Also, a saline water cooling system verification program is being programed for FY 1985. Saline water cooling system technology will be tested at an existing powerplant. This appears to be the most cost-effective way to verify the use of saline water to provide salinity control benefits and to address industries' concerns regarding equipment reliability.

In summary, we believe the Proposed 1984 Review - Water Quality Standards for Salinity, Colorado River System, which confirms the numeric criteria and updates the plan of implementation for salinity control, is an excellent review of the established standards. We concur in the adequacy of the numeric criteria for the next 3 years and in the plan of implementation. We look forward to continued close cooperation with the Forum, the Basin States, and Federal agencies in implementing the control program.

United States Department of Agriculture
Soil Conservation Service
P.O. Box 2890
Washington, D.C. 20013

JUN 27 1984

Mr. Jack Barnett
Executive Director
Colorado River Basin
Salinity Control Forum
106 West 500 South, Suite 101
Bountiful, Utah 84010

Dear Mr. Barnett:

On behalf of the Department of Agriculture (USDA), we have reviewed the report on the 1984 Review of Water Quality Standards for Salinity, Colorado River System. The document is comprehensive and well prepared.

We concur with the recommendations in the proposed implementation plan to accelerate the more cost-effective USDA onfarm salinity control projects. Our recent legislative and budget initiatives have been directed toward that objective.

USDA recognizes the short-term beneficial impacts of high runoff excessive flow conditions on reducing salinity concentrations, but hasten to advise that total salt loadings have most probably increased.

The potential for severe long-term impacts and increasing salinity levels remain almost inevitable without upstream salinity control efforts.

We appreciate the Forum's legislative initiative to expand PL-93-320 and the efforts to accelerate salinity control throughout the Colorado River Basin.

Sincerely,

Edgar H. Nelson

EDGAR H. NELSON
USDA Salinity Control Liaison
Office

cc:
Mr. David Robbins, Chairman, CRBSC Forum
Mr. Ernie Weber, Chairman, Forum Work Group

OFFICE OF THE COMMISSIONER
UNITED STATES SECTION

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO
IBWC BUILDING
4110 RIO BRAVO
EL PASO, TEXAS 79902

JUN 2 9 1984

Mr. Jack A. Barnett
Executive Director
Colorado River Basin
Salinity Control Forum
106 West 500 South, Suite 101
Bountiful, Utah 84010

Dear Jack:

Thank you for your letter of June 11, 1984 enclosing a copy of the proposed report on the "1984 Review of Water Quality Standards for Salinity Colorado River System" prepared by the Colorado River Basin Salinity Control Forum pursuant to P.L. 92-500.

We note in the 1984 review that the Forum finds no reason to recommend changes in the numeric salinity criteria at the three lower main stem stations and that there is no reason to believe that the numeric criteria will be exceeded during the next 3-year review period.

I appreciate the good work of the Forum and commend you on the excellent report.

Sincerely yours,

J.F. Friedkin
Commissioner

MODIFICATIONS

On the basis of statements made at the regional public meetings held in Rock Springs, Wyoming, on June 25, 1984, and Las Vegas, Nevada, on June 27, 1984, and on written comments dated June 30, 1984 or before; and to correct minor errors, the following modifications to the "1984 Review - Water Quality Standards for Salinity, Colorado River System" were approved by the Colorado River Basin Salinity Control Forum on July 25, 1984.

Page 14, Figure 2: Bottom scale on graph should read "Calendar Year" rather than "Fiscal Year".

Page 27, 2nd paragraph under Temporary Increases: The sentence should read: "The salinity control plan is designed to keep any temporary increases above the numeric criteria to a minimum as well as reduce the duration of such temporary increases".

Attached are: 1) "Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program", 1977 and; 2) Policy for Use of Brackish and/or Saline Waters for Industrial Purposes", 1980.

Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program

Prepared by

The Colorado River Basin Salinity Control Forum

February 28, 1977

In November 1976, the United States Environmental Protection Agency Regional Administrators notified each of the seven Colorado River Basin states of the approval of the water quality standards for salinity for the Colorado River System as contained in the document entitled "Proposed Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System, June 1975," and the supplement dated August 25, 1975. The salinity standards including numeric criteria and a plan of implementation provide for a flow weighted average annual numeric criteria for three stations in the lower main stem of the Colorado River: below Hoover Dam, below Parker Dam, and at Imperial Dam.

The Plan of Implementation is comprised of a number of Federal and non-Federal projects and measures to maintain the flow-weighted average annual salinity in the Lower Colorado River at or below numeric criteria at the three stations as the Upper and Lower Basin states continue to develop their compact-apportioned waters. One of the components of the Plan consists of the placing of effluent limitations, through

the National Pollutant Discharge Elimination System (NPDES) permit program, on industrial and municipal discharges.

The purpose of this policy is to provide more detailed guidance in the application of salinity standards developed pursuant to Section 303 and through the NPDES permitting authority in the regulation of municipal and industrial sources. (See Section 402 of the Federal Water Pollution Control Act.) This policy is applicable to discharges that would have an impact, either direct or indirect on the lower main stem of the Colorado River System. The lower main stem is defined as that portion of the main river from Hoover Dam to Imperial Dam.

I. Industrial Sources

The Salinity Standards state that "the objective for discharges shall be a no-salt return policy whenever practicable." This is the policy that shall be followed in issuing NPDES discharge permits for all new industrial sources, and upon the reissuance of permits for all existing industrial sources, except as provided herein. The following addresses those cases where no-discharge of salt may be deemed not to be practicable.

A. New Construction

1. New construction is defined as any facility from which a discharge may occur, the construction of which is commenced after October 18, 1975. (Date of submittal of water quality standards

as required by 40 CFR 120, December 11, 1974.) Appendix A provides guidance on new construction determination.

a. The permitting authority may permit the discharge of salt upon a satisfactory demonstration by the permittee that it is not practicable to prevent the discharge of all salt from proposed new construction.

b. The demonstration by the applicant must include information on the following factors relating to the potential discharge:

   (1) Description of the proposed new construction.

   (2) Description of the quantity and salinity of the water supply.

   (3) Description of water rights, including diversions and consumptive use quantities.

   (4) Alternative plans that could reduce or eliminate salt discharge. Alternative plans shall include:

      (a) Description of alternative water supplies, including provisions for water reuse, if any.

      (b) Description of quantity and quality of proposed discharge.

(c) Description of how salts removed from discharges shall be disposed of to prevent such salts from entering surface waters or ground water aquifers.

(d) Costs of alternative plans in dollars per ton of salt removed.

(5) Of the alternatives, a statement as to the one plan for reduction of saltdischarge that the applicant recommends be adopted.

(6) Such other information pertinent to demonstration of non-practicability as the permitting authority may deem necessary.

c. In determining what permit conditions shall be required, the permit issuing authority shall consider, but not be limited to the following:

(1) The practicability of achieving no discharge of salt.

(2) Where no discharge is determined not to be practicable:

(a) The impact of the total proposed salt discharge of each alternative on the lower main stem in terms of both tons per year and concentration.

(b) Costs per ton of salt removed from the discharge for each plan alternative.

(c) Capability of minimizing salinity discharge.

(3) With regard to both points, one and two above, the compatibility of state water laws with either the complete elimination of a salt discharge or any plan for minimizing a salt discharge.

(4) The no-salt discharge requirement may be waived in those cases where the salt load reaching the main stem of the Colorado River is less than one ton per day or 350 tons per year, whichever is less. Evaluation will be made on a case-by-case basis.

B. Existing Facilities

1. The permitting authority may permit the discharge of salt upon a satisfactory demonstration by the permittee that it is not practicable to prevent the discharge of all salt from an existing facility.

2. The demonstration by the applicant must include information, in addition to that required under Section I, A, 1, b; the following factors relating to the potential discharge:

(a) Existing tonnage of salt discharged and volume of effluent.

(b) Cost of modifying existing industrial plant to provide for no salt discharge.

(c) Cost of salt minimization.

3. In determining what permit conditions shall be required, the permit issuing authority shall consider the items presented under I, a, 1, c (2), and in addition; the annual costs of plant modification in terms of dollars per ton of salt removed for:

    a) No salt return.

    b) Minimizing salt return.

4. The no-salt discharge requirement may be waived in those cases where the salt load reaching the main stem of the Colorado River is less than one ton per day or 350 tons per year, whichever is less. Evaluation will be made on a case-by-case basis.

II. Municipal Discharges

The basic policy is that a reasonable increase in salinity shall be established for municipal discharges to any portion of the Colorado River stream system that has an impact on the lower main stem. The incremental increase in salinity shall be 400 mg/l or less, which is considered to be a reasonable incremental increase above

the flow weighted average salinity of the intake water supply.

A. The permitting authority may permit a discharge in excess of the 400 mg/l incremental increase at the time of issuance or reissuance of a NPDES discharge permit, upon satisfactory demonstration by the permittee that it is not practicable to attain the 400 mg/l limit.

B. Demonstration by the applicant must include information on the following factors relating to the potential discharge:

1. Description of the municipal entity and facilities.
2. Description of the quantity and salinity of intake water sources.
3. Description of significant salt sources of the municipal wastewater collection system, and identification of entities responsible for each source, if available.
4. Description of water rights, including diversions and consumptive use quantities.
5. Description of the wastewater discharge, covering location, receiving waters, quantity, salt load, and salinity.
6. Alternative plans for minimizing salt contribution from the municipal discharge. Alternative plans should include:

(a) Description of system salt sources and alternative means of control.

(b) Cost of alternative plans in dollars per ton, of salt removed from discharge.

7. Such other information pertinent to demonstration of non-practicability as the permitting authority may deem necessary.

C. In determining what permit conditions shall be required, the permit issuing authority shall consider the following criteria including, but not limited to:

1. The practicability of achieving the 400 mg/l incremental increase.

2. Where the 400 mg/l incremental increase is not determined to be practicable:

(a) The impact of the proposed salt input of each alternative on the lower main stem in terms of tons per year and concentration.

(b) Costs per ton of salt removed from discharge of each alternative plan.

(c) Capability of minimizing the salt discharge.

D. If, in the opinion of the permitting authority, the data base for the municipal waste discharger is inadequate, the permit will contain the requirement that the municipal waste discharger monitor the water supply and the wastewater dischahrge for salinity.

Such monitoring program shall be completed within 2 years and the discharger shall then present the information as specified above.

E. Requirements for establishing incremental increases may be waived in those cases where the incremental salt load reaching the main stem of the Colorado River is less than one ton per day or 350 tons per year, whichever is less. Evaluation ill be made on a case-by-case basis.

F. All new and reissued NPDES permits for all municipalities shall require monitoring of the salinity of the intake water supply and the wastewater treatment plant effluent in accordance with the following guidelines:

Treatment Plant Design Capacity	Monitoring Frequency	Type of Sample
<1.0 MGD	Quarterly	Discrete
1.0 - 5.0 MGD	Monthly	Composite
>5.0 - 50.0 MGD	Weekly	Composite
50.0 MGD	Daily	Composite

1. Analysis for salinity may be either as total dissolved solids (TDS) or by electrical conductivity where a satisfactory correlation with TDS has been established. The correlation should be based on a minimum of five different samples.

2. Monitoring of the intake water supply may be at a reduced frequency where the salinity of the water supply is relatively uniform.

APPENDIX A

GUIDANCE ON NEW CONSTRUCTION DETERMINATION

For purposes of determining a new construction, a source should be considered new if by October 18, 1975, there has not been:

(1) Significant site preparation work such as major clearing or excavation; and/or

(2) Placement, assembly, or installation of unique facilities or equipment at the premises where such facilities or equipment will be used; and/or

(3) Any contractual obligation to purchase unique facilities or equipment. Facilities and equipment shall include only the major items listed below, provided that the value of such items represents a substantial commitment to construct the facility:

(a) structures; or

(b) structural materials; or

(c) machinery; or

(d) process equipment; or

(e) construction equipment.

(4) Contractural obligation with a firm to design, engineer, and erect a completed facility (i.e., a turnkey plant).

Policy for Use of Brackish and/or Saline Waters for Industrial Purposes

by

The Colorado River Basin Salinity Control Forum
September 11, 1980

The States of the Colorado River Basin, the federal Executive Department, and the Congress have all adopted as a policy that the salinity in the lower mainstem of the Colorado River shall be maintained at or below the flow-weighted average values found during 1972 while the Basin states continue to develop their compact-apportioned waters. In order to achieve this policy, all steps which are practical and within the framework of the administration of states' water rights must be taken to reduce the salt load of the river. One such step was the adoption in 1975 by the Forum of a policy regarding effluent limitations for industrial discharges with the objective of no-salt return wherever practicable. Another step was the Forum's adoption in 1977 of the "Policy for Implementation of Colorado River Salinity Standards through NPDES Permit Program." These policies are part of the basinwide plan of implementation for salinity control which has been adopted by the seven Basin states.

The Forum finds that the objective of maintaining 1972 salinity levels would be served by the exercise of all feasible measures including, wherever practicable, the use of brackish and/or saline waters for industrial purposes.

The summary and on page 32 of the Forum's 1978 Revision of the Water Quality Standards for Salinity states "The plan also contemplates the use of saline water for industrial purposes whenever practicable, ..." In order to implement this concept, and thereby further extend the Forum's basic salinity policies, the Colorado River Basin states support the Water and Power Resources Service appraisal study of saline water collection, pretreatment and potential industrial use.

The Colorado River Basin contains large energy resources, which are in the early stages of development. The WPRS study should investigate the technical and financial feasibility of serving as significant portion of the water requirements of the energy industry and any other industries by the use of Basin brackish and/or saline waters. The Forum recommends that:

1) The Colorado River Basin states, working with federal agencies, identify, locate and quantify such brackish and/or saline water sources.

2) Information on the availability of these waters be made available to all potential users.

3) Each state encourage and promote the use of such brackish and/or saline waters, except where it would not be environmentally sound or economically feasible or would significantly increase consumptive use of Colorado River System water in that State above that which would otherwise occur.

4) The U.S. Water and Power Resources Service with the assistance of the States encourage and promote the use of brackish return flows from federal irrigation projects in lieu of fresh water sources except where it would not be environmentally sound or economically feasible or would significantly increase consumptive use of Colorado River System water.

5) The U.S. Water and Power Resources Service consider a federal contribution to the cost of industrial use of brackish and/or saline water where cost effective as a joint private-government salinity control measure. Such activities shall not delay the implementation of the salinity control projects identified in Title II of P.L. 93-320.